ESD-TR-71-80

MTR-1995

AIRCRAFT MOCK-UP COMPUTER PROGRAM SPECIFICATIONS

R. E. Zapolin

MARCH 1971

Prepared for

DEPUTY FOR PLANNING AND TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

Project 5170
Prepared by
THE MITRE CORPORATION
Bedford, Massachusetts
Contract F19(628)-71-C-0002

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FOREWORD

The MITRE Corporation of Bedford, Mass. is providing technical support to Hq ESD under contract number F19(628)-71-C-0002. This TR represents a portion of their effort on the Position Location, Reporting and Control of Tactical Aircraft (PLRACTA) Advanced Development Program, Project 687C of program element 63706F.

Briefly, PLRACTA addresses deficiencies in communication, navigation and identification for tactical aircraft. The PLRACTA concept requires digital communications using a TDMA signal structure over a common frequency for all users resulting in a dynamic information source available to any member of the tactical community for extraction of needed data for his specific mission.

A "proof of concept" demonstration will be conducted using tactical elements equipped with PLRACTA terminals. The ground elements in the PLRACTA test facilities are a TACC, CRC, Remote User and Aircraft Mock-up. Support aircraft will test G-A-G, A-G, and A-A communications and navigation techniques. The mock-up will be an austere forerunner of an aircraft with PLRACTA equipment operated by the pilot.

REVIEW AND APPROVAL

Publication of this technical report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

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ABSTRACT

A computer program operating in the DEC PDP-15 will simulate programs in avionics computers aboard the two simulated jet aircraft. General performance and design specifications for this computer program, program organization and a phasing plan are presented. Further detail will be published in the PLRACTA System Test Configuration documentation.

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SECTION I

INTRODUCTION

The computer program operating in the Digital Equipment Corporation PDP-15/20 will simulate the programs in avionics computers aboard two simulated jet aircraft during the PLRACTA Advanced Development Program. These computer programs will perform functional calculations for a variety of tactical aircraft, all simulated by two Link Aviation C-11C trainers. These will include strike aircraft, fighter aircraft, search and rescue, Airborne Forward Air Controller aircraft, tankers, reconnaissance and electronic counter measure aircraft. The program will control the generation and display of data in the cockpits of both trainers. Within each trainer displays will be on a cathode ray tube (CRT) mounted in the instrument panel and on a Head-Up display. An additional capability will be provided to monitor any single Panel or Head-Up cockpit display at a standard floor console for checkout or demonstration.

The testbed implementation makes it necessary that both avionics computers be simulated by a single machine. The testbed computer selected is the Digital Equipment Corporation (DEC) PDP-15/20, an 18 bit 800 nanosecond digital computer. Overall characteristics are given in Table I.

TABLE I

PDP-15/20 CHARACTERISTICS

TYPE	GENERAL-PURPOSE, STORED PROGRAM, PARALLEL, FIXED POINT, BINARY
MEMORY CYCLE	800 NANOSECONDS
ARITHMETIC	ONE'S AND TWO'S COMPLEMENT
STORAGE	16,384 EIGHTEEN-BIT WORDS CORE
DATA WORD	18 BITS, NO PARITY
INDEXING	ONE HARD REGISTER, EIGHT AUTO-INCREMENT LOCATIONS
EXECUTION TIMES (MICROSECONDS)	ADD 1.60
	MULTIPLY 7.00
	DIVIDE 7.25
I/O DATA RATE (WORDS PER SECOND)	SINGLE CYCLE 1,000,000
	MULTI-CYCLE - IN 181,000
	MULTI-CYCLE - OUT 250,000
INTERRUPTS	AUTOMATIC PRIORITY: 4 HARDWARE LEVELS, UP TO 8 DEVICES PER LEVEL, 28 DEVICES TOTAL; 4 SOFTWARE LEVELS

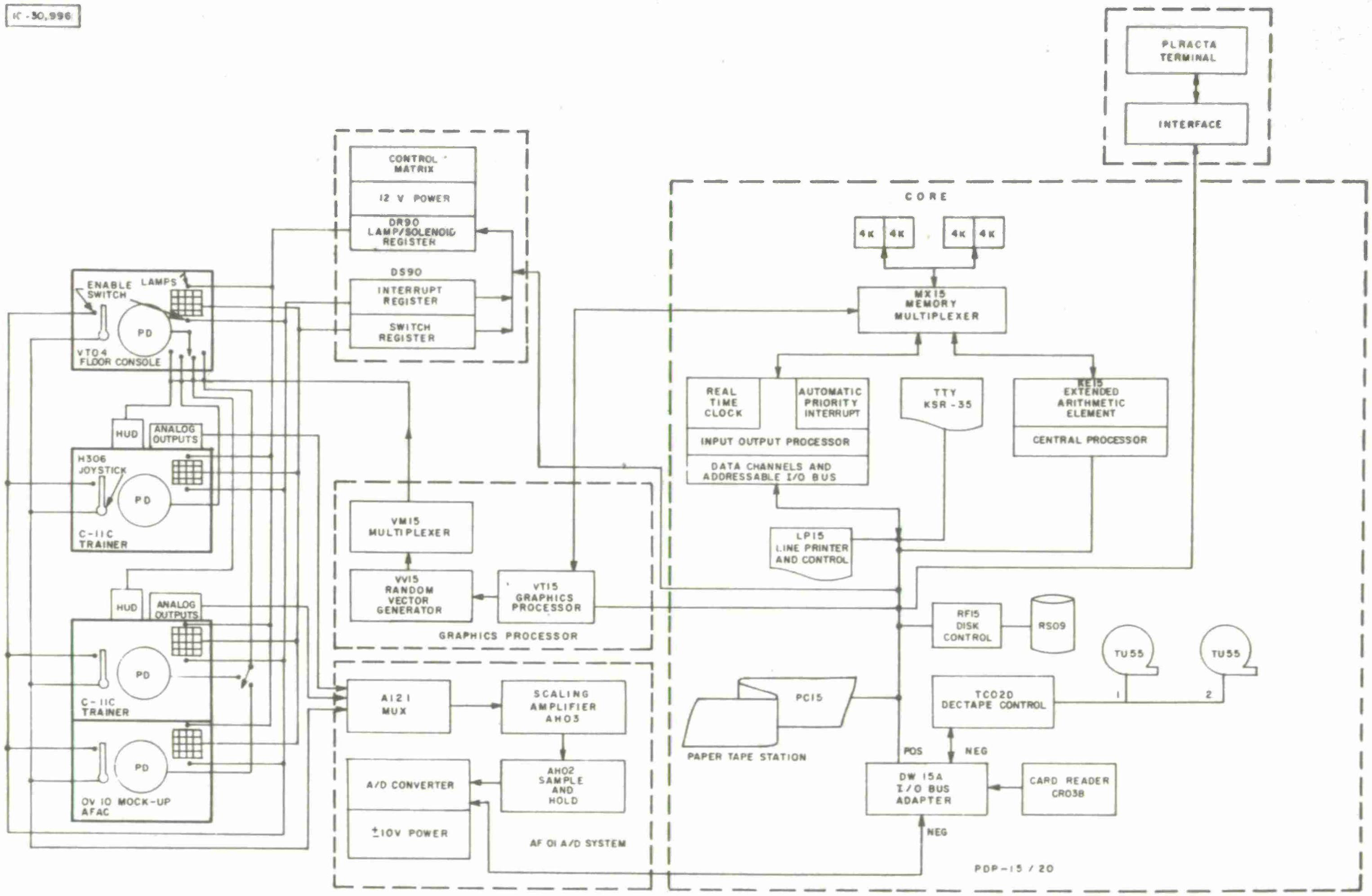


Figure 1. System Information Flow Diagram

Data flow in the system is shown in Figure 1. Note the processor with extensive input-output capabilities; the graphic processor to prepare four sets of displays, the analog-to-digital conversion subsystem to process trainer flight parameters, and two trainers to simulate the tactical aircraft.

The requirements for each of the major functions of the operational program are discussed in Section II. Not all capabilities are to be provided until completion of the Full Capability program package. The organization and phasing of the program packages are discussed in Section III. This document presents the general performance and design requirements for these programs. Subsequent publications in the PLRACTA System Test Configuration documentation series will develop complete mathematical and functional specifications to supplement this document.

SECTION II

FUNCTIONAL PROGRAMS

MAJOR FUNCTIONS

The specific functions to be performed by the computer program will vary with the mission assigned, the phase of operation being performed, and the type of aircraft being simulated. There are eight major functions common to all aircraft and present in some form during all missions. An additional function, Air-to-Ground Attack, is performed only by strike aircraft. Each function is outlined below and discussed in subsequent sections.

Filtering

The Filtering function retains or deletes information from PLRACTA network messages based upon the message addressing and content, in accordance with preset logic and filters set by the pilot.

Data Exchange

The Data Exchange function accepts messages from the network which were received by the PLRACTA terminal and transferred to the PDP-15 by the interfacing DEC PDP-8 computer or directly from the IBM 4π computer. It also transfers messages prepared by the PDP-15 out to the PDP-8 or directly to the 4π for transmission.

Flight Data Input

The Flight Data Input function accepts, scales and verifies digitized analog signals from each of the two C-11C jet aircraft trainers.

Display Preparation

The Display Preparation function prepares and updates four independent graphics displays, with content dependent on preset logic and operator options.

Switch Inputs

The Switch Inputs function reads, verifies, and responds to operator insertions at four sets of sixteen switches and at four joysticks.

Simulation Input Processing

The Simulation Input Processing function reads simulated data into tables and items for program checkout, initialization and system testing.

Recording

The Recording function outputs data onto magnetic tape for later analysis.

Navigation

The Navigation function provides steering information to vector each trainer to a fixed or moving location.

Air-to-Ground Attack

The Air-to-Ground Attack function, unique to strike aircraft, computes the release time and the bomb impact point for several bombing mode options.

FILTERING

All messages shall be subjected to primary and secondary filtering, based upon pilot insertion of options and preset logic. With no filters selected all messages shall be accepted for further processing. Certain types of messages shall not be subjected to filtering, since they are directed to the aircraft or serve a safety function. Every other type of message shall be filterable by the pilot using the logic shown in the following two sections. A preset geographical filter, based upon the chosen situation display scale factor, shall operate as described below.

Primary Filter Logic

The Primary Filter Logic shall permit selection by switch action of those messages which are to be passed by the filter logic associated with each trainer. The pilot shall be able to select data pertaining only to his own mission, data on hostile tracks, ground hostile tracks or friendly class tracks. Independent of pilot action, the filter logic shall pass all Surface-to-Air (SAM) Engagement messages, all messages addressed to this trainer, and all messages addressed to all aircraft. All messages which are accepted shall be stored in a filter buffer for further processing. All other messages shall not be inserted into the central tables. The information flow for this logic shall be as shown in Figure 2.

Secondary Filter Logic

The Secondary Filter Logic shall permit selection of the information retained from the messages passed by the primary filter. For example, the pilot of a cover aircraft would want to know the position of all hostile class aircraft while the pilot of a Search-and-Rescue (SAR) aircraft would want to know the location and emergency status of friendly class aircraft. Only those messages already passed by the primary filter shall be available to be filtered further. The secondary logic shall examine the filter bit settings for each message passed by the primary filter. If the message is one which is not filterable, all its data shall be entered into the central tables. If it is a message which was accepted by a filter, the pilot-selected options accompanying the primary filter (the "co-filters") shall be examined. If the co-filter indicates that the information is to be accepted, a bit shall be set for the data items indicated by the co-filter ("co-tag"). After all filter-co-filter combinations have been searched and all co-tags applied, the logic shall purge all untagged information and enter only the remainder into the central tables. The information flow for this logic shall be as shown in Figure 3.

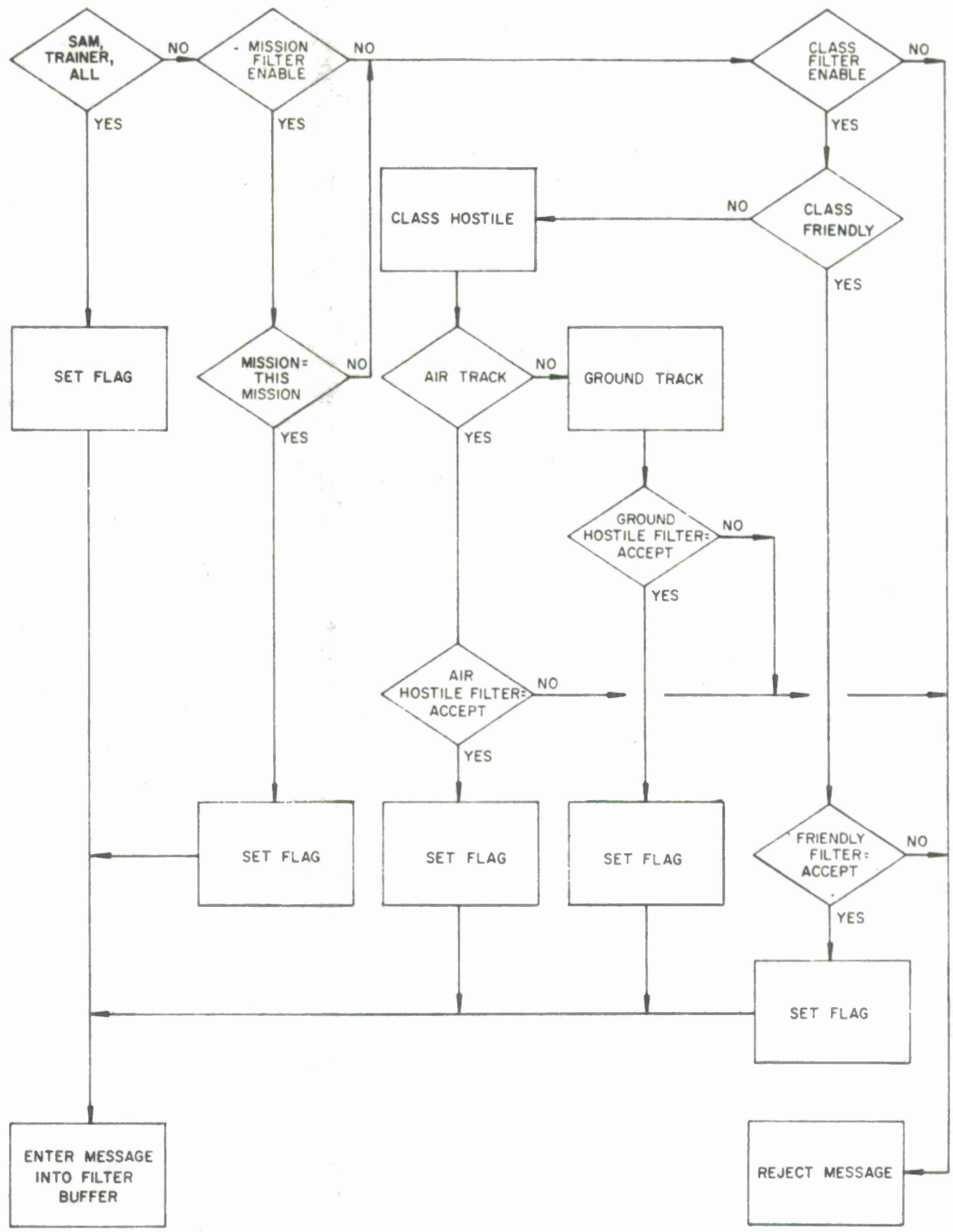


Figure 2. Primary Filter Logic

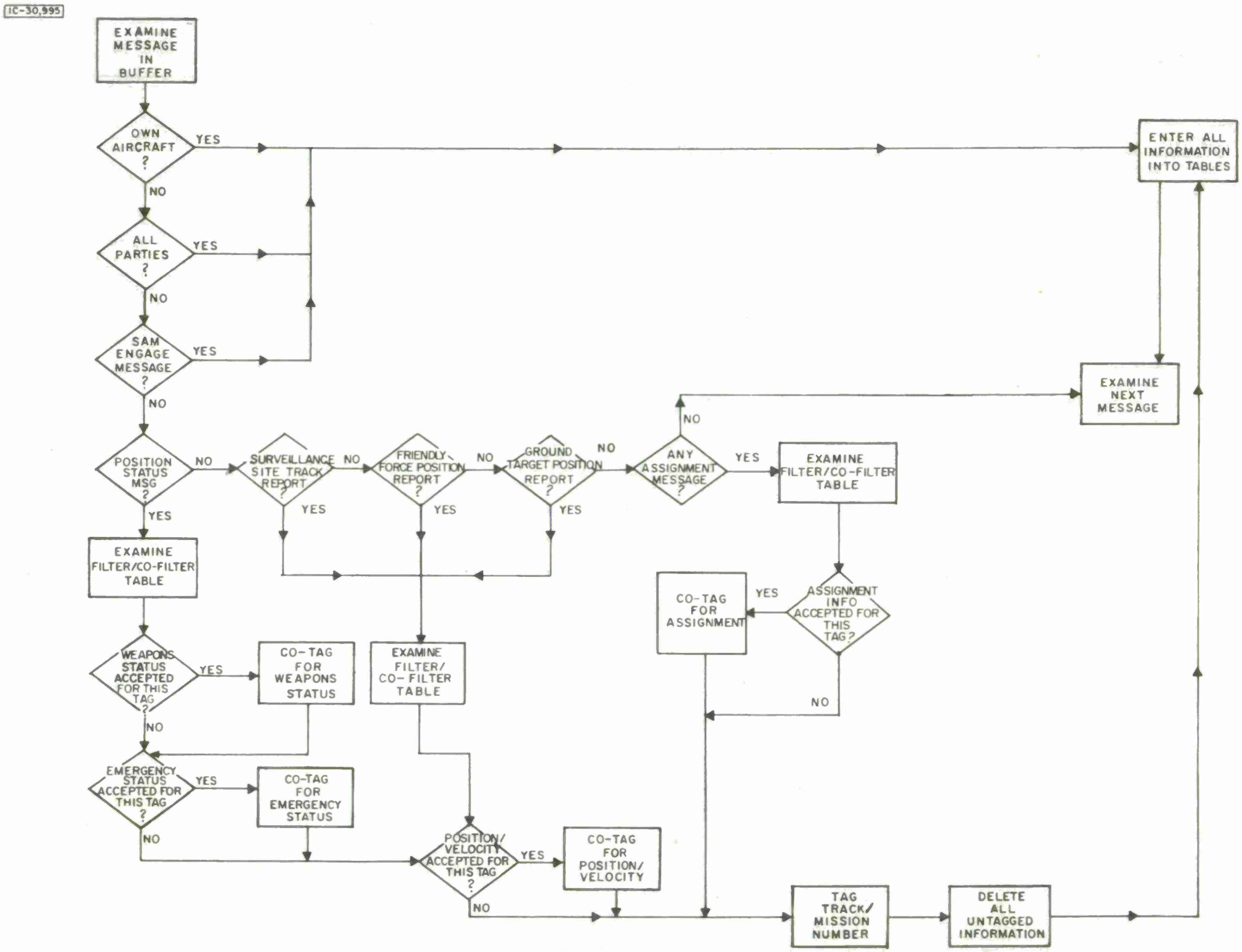


Figure 3. Secondary Filter Logic

Geographic Filter Logic

While the Situation Display is selected the scale factor chosen shall be used as a filter criterion for message processing. Any filterable message which is more than a preset multiple of the display area diameter from the display center shall not be accepted into the central tables. This filtering shall occur prior to operation of the Primary Filter Logic.

DATA EXCHANGE

All messages on the PLRACTA network shall be received for processing by the PDP-15. An IBM 4π computer will accept radio message inputs and transfer them either directly to the PDP-15 or to a PDP-8 serving as a message distribution multiplexer. An IB-15 interface buffer between the 4π, PDP-8 and the PDP-15 will input the message into the PDP-15 memory as a block transfer of data. Messages prepared by the PDP-15 will be output to the IB-15 for transfer either to the PDP-8 or directly to the 4π.

Messages appropriate for the type of aircraft being simulated with the trainers shall be prepared for transmission, with data values based upon flight inputs, operator insertions, and calculations.

Input messages shall be received and stacked for filtering and further processing 100 times per second. Output messages shall be sent once from each trainer during each ten second PLRACTA information cycle. Message types and data fields and number of repetitions shall be in accordance with PLRACTA System Test Configuration documentation.

FLIGHT DATA INPUT

Integration of aircraft flight data into the PLRACTA Position-Status Report will be simulated by taking flight parameters as DC analog signals from each C-11C jet trainer, converting them to digital form, and inputting them into the PDP-15 computer. As an example, a precision potentiometer will be mounted on the output shaft of the altitude servo so that its resistance will vary with shaft rotation. The fraction of a stable input voltage output by this potentiometer will be a function of shaft position, analogous to flight altitude by a simple conversion factor such as +1 millivolt equals +5 feet. The analog voltages will be multiplexed and converted one-at-a-time to digital signals.

In addition to the flight information, the cursor location for each joystick will be digitized.

The Flight Data Input function shall control the conversion, scale the inputs, error-check the inputs and compute additional data, as detailed below.

Conversion Control

The signals to be processed from each C-11C trainer will be those listed in Table II. Each will be assigned to one or more multiplexer channels. All channels may be read in sequence periodically or selected channels may be read more frequently than others, or selected channels may be read when their data is required. No data used for a calculation shall be older than 100 milliseconds. As a worst case this will represent 320 conversions per second. Each conversion will yield a nine bit digital value.

TABLE II

PARAMETERS TO BE DIGITIZED

	PARAMETER	TRAINER SYMBOL	MAXIMUM VALUE
1.	TRUE VELOCITY	V_P	533 kt
2.	AZIMUTH ANGLE SINE	Ψ	$\pm$ 1
3.	AZIMUTH ANGLE COSINE	Ψ	$\pm$ 1
4.	FLIGHT PATH ELEVATION ANGLE SINE	β	$\pm$ 1
5.	FLIGHT PATH ELEVATION ANGLE COSINE	β	$\pm$ 1
6.	VERTICAL ACCELERATION	a_{Z_a}	ft/sec^2
7.	ALTITUDE	h	50 K ft.
8.	ANGLE OF ATTACK	α	-10° $+20^\circ$
9.	YAW ANGLE	γ	$\pm 15^\circ$
10.	BANK ANGLE SINE	ϕ	$\pm$ 1
11.	BANK ANGLE COSINE	ϕ	$\pm$ 1
12.	FUEL QUANTITY	-	430 gal
13.	JOYSTICK COORDINATE	X	$\pm$ 300 nm
14.	JOYSTICK COORDINATE	Y	$\pm$ 300 nm

Scaling

Each input value shall be scaled in accordance with prestored conversion factors to yield units consistent with the requirements of functional programs which will use the data.

Verification

Each input value shall be error-checked against prestored limits to ensure that equipment failure does not cause large errors through the acceptance of out-of-tolerance inputs. Values which are within limits shall be entered into the central tables. Values which are out of limits shall cause a message identifying time, parameter name, converter multiplexer channel and error value to be output on the line printer.

Computation

All angles input from the C-11C trainers will be represented by their sines and cosines to avoid the use of sine and cosine subroutines in the PDP-15 software. The trainer position and velocity components shall be computed by the PDP-15 software in accordance with the equations in Table III.

TABLE III

FLIGHT SIGNAL COMPUTATION

n = Present Value   n-1 = Previous Value   T = Time

X_n	=	Present X coordinate	=	$X_{n-1} + \left(V_{X_n}\right)\left(T_n - T_{n-1}\right)$
Y_n	=	Present Y coordinate	=	$Y_{n-1} + \left(V_{Y_n}\right)\left(T_n - T_{n-1}\right)$
V_{H_n}	=	Present horizontal velocity	=	$\left(V_p\right)\left(\text{cosine } \beta\right)$
V_{X_n}	=	Present X velocity component	=	$\left(V_H\right)\left(\text{cosine} \psi\right)$
V_Y	=	Present Y velocity component	=	$\left(V_H\right)\left(\text{sine } \psi\right)$
V_Z	=	Present Z velocity component	=	$\left(V_{p_n}\right)\left(\text{sine } \beta\right)$

DISPLAY PREPARATION

Network information, manual insertions and messages will be presented to the pilot on either of two display surfaces; the Panel Display, a five-inch cathode ray tube (CRT) mounted in the cockpit instrument panel; or the Head-Up Display mounted on the windscreen. Two display formats, Text and Situation described below, shall be presentable on the Panel Displays. Two other formats, Navigation and Attack described below, shall be presentable on the Head-Up Displays. Two additional display formats, Startup and Equipment Checkout described below, shall be available during the running of special purpose programs. A display format to aid Airborne Forward Air Controller (AFAC) message composition shall be available on the AFAC panel display, as described below.

Display information shall be updated ten times per second. Displays will be refreshed thirty times per second. The number of vectors and characters in each display is shown in Table IV.

TABLE IV

OPERATIONAL DISPLAY SUMMARY

TITLE	SURFACE PANEL	SURFACE HUD	SHORT VECTORS	LONG VECTORS	CHARACTERS
TEXT	X	--	0	0	500
SITUATION	X	--	60	7	181
NAVIGATION	--	X	108	15	99
ATTACK	--	X	79	35	38
TOTALS			247	57	818

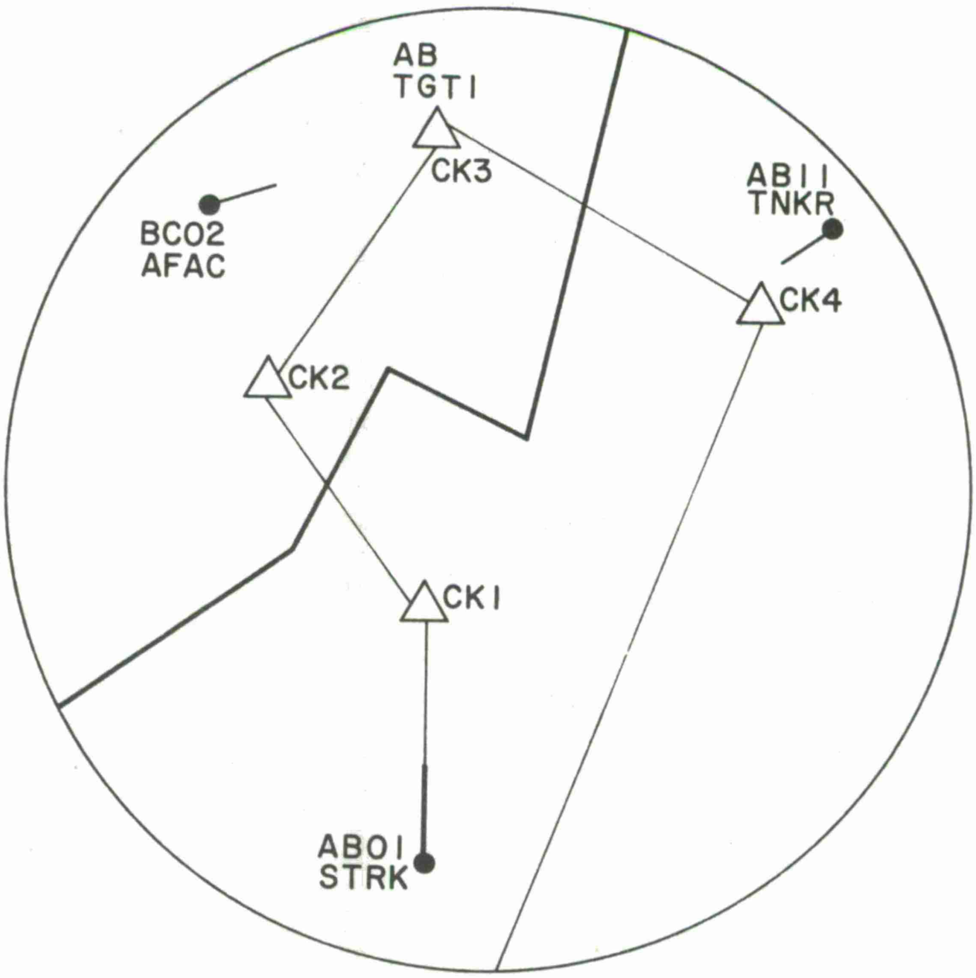


Figure 4. Situation Display

Text Display

The Text Display shall be addressable only to the Panel Display. It shall present formatted text with a maximum of 500 characters per page, each character to subtend an angle of 12 minutes of arc on the retina of a pilot seated 36" from the display. This is equivalent to 1/8" high letters. Formats shall include message text, message detail, selection outline for choice of detailed text, warnings, and urgent notices.

The pilot shall have the options of alternating between text pages by function switch and of selecting detailed displays by positioning the joystick cursor over a display-selection outline.

Situation Display

The Situation Display shall be addressable only to the Panel Displays. It shall present a situation display with a selectable origin, selectable orientation, and selectable scale.

Content shall include up to 50 short vecotors for border and warning area display; up to six flight path way points with a unique symbol, ten character identifiers and long vectors connecting the check points; up to ten aircraft with a unique symbol, a short vector proportional to velocity, and ten character identifiers; up to five interdiction or rendezvous points with unique symbols and long vectors connecting trainers and targets.

Options shall be provided for the operator to designate the display origin by function switch and joystick inputs to choose either a North-Up or an Aircraft Heading-Up orientation, and to select among four scale factors. Scale factors shall be modifiable by changes to the central tables. The ratio of smallest to largest possible scale factor shall be 1 to 100. Figure 4 shows a typical situation display, by means of which the pilot of trainer AB01 can view his full flight route, can see the other participants in his mission, can see his target and can note that this flight path crosses a border.

Navigation Display

The Navigation Display shall be addressable only to the Head-Up Displays. It shall provide the information that the pilot needs to navigate to a specific target and to determine the status of the mission in progress, including preset flight information, flight direction information, and mission status information as discussed below. Displays shall contain the vectors and characters shown in Table V.

TABLE V

CONTENT OF NAVIGATION DISPLAY

PRESENT FLIGHT INFORMATION ON LINEAR SCALES

HEADING

- 9 SHORT VECTORS (4 BLANKED RETURNS) FOR SCALE
- 10 DIGITAL CHARACTERS ON HORIZONTAL LINE
- 12 SHORT VECTORS FOR THREE POINTERS

SPEED

- 19 SHORT VECTORS (9 BLANKED RETURNS) FOR SCALE
- 8 SHORT VECTORS FOR TWO POINTERS
- 5 DIGITAL CHARACTERS ON TWO HORIZONTAL LINES
- 2 LONG VECTORS FOR INDICATOR

ALTITUDE

- 19 SHORT VECTORS (9 BLANKED RETURNS) FOR SCALE
- 8 SHORT VECTORS FOR TWO POINTERS
- 5 DIGITAL CHARACTERS ON TWO HORIZONTAL LINES
- 2 LONG VECTORS FOR INDICATOR

FLIGHT DIRECTION INFORMATION

HORIZON AND PITCH LINES

- 11 LONG VECTORS (5 BLANKED RETURNS)
- 18 ALPHANUMERIC CHARACTERS
- 6 SHORT VECTORS

FLIGHT PATH MARKER

- 8 SHORT VECTORS (CIRCLE)
- 5 SHORT VECTORS (2 BLANKED LINES)

FLIGHT DIRECTOR

- 8 SHORT VECTORS (CIRCLE)
- 1 SHORT VECTOR

TARGET MARKER

- 5 SHORT VECTORS (1 BLANKED RETURN)
- 1 CHARACTER

MISSION STATUS

TEXT

ALPHANUMERIC CHARACTERS (FUEL, RANGE, TIME TO RENDEZVOUS OR INTERDICTION, CONTROL FACILITY, IMPOSSIBLE REASON)

Options shall be provided for function switch inputs of target and mission. No options shall be provided to change display content.

An example of this display is shown in Figure 5. On this display, height of the bar on the left-hand linear scale will indicate trainer speed is 543 knots. Height of the bar on the right-hand linear scale indicates trainer altitude is 15,630 feet. Position of scale next to bottom pointer will indicate heading is 350°. The triangular pointers indicate target speed and bearing. Note that the target altitude of 45,000 feet is offscale and is replaced by a number followed by T. Command speed is indicated by three horizontal lines. Command heading and altitude are indicated by the solid flight director circle which the pilot tries to move back to the center location. Alignment indicates that he is following his commanded directions. In this example the trainer is in a right-hand climbing turn, as commanded, and the pitch and horizon lines show banking combined with a 5° climb.

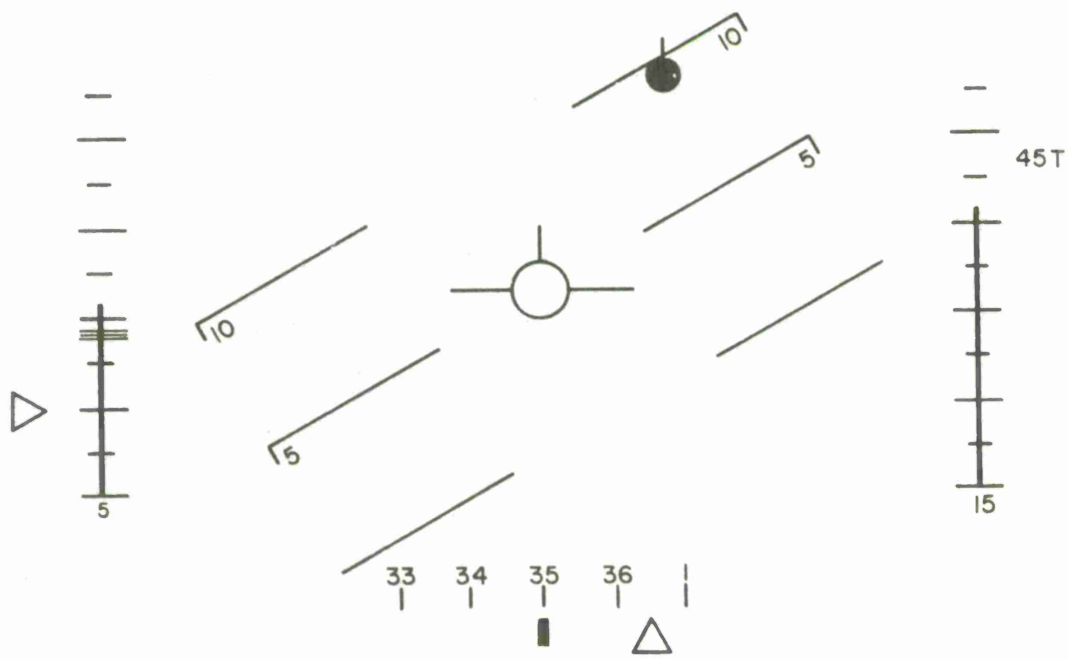


Figure 5. Navigation Display

Present Flight Information

Linear scales with pointers shall show the commanded and actual speed, heading and altitude values. Off scale values shall be indicated by their numeric value and the tag of T for target or a blank for trainer.

Flight Direction Information

A flight director presentation shall provide steering information to permit the pilot to follow altitude and heading commands by centering the flight director circle over the flight path marker. Pitch lines shall indicate the extent of trainer nose-up or nose-down attitude and horizon lines shall indicate the angle of banking. A distinctive marker shall indicate the location of the target toward which the trainer is being vectored.

Mission Status Information

The Mission Status Information is a block of text which contains the fuel, range to target, time until interdiction, control facility identification, or reason for impossible interdiction.

Attack Display

The Attack Display shall be addressable only to the Head-Up Displays. It shall provide vectoring to the target, solution cues to mark the release times, a bomb fall line to mark the bomb's ground target, pull-up anticipation cues and commands, and warning indicators. Vector and character content shall be as shown in Table VI.

TABLE VI

\- CONTENT OF AIR-TO-GROUND DISPLAY -

● VECTORING AND FLIGHT INFORMATION	● SOLUTION CUES
SIMILAR TO NAVIGATION DISPLAY, EXCEPT	2 LONG VECTORS
TARGET MARKER	2 SHORT VECTORS
4 SHORT VECTORS	
● PULL-UP ANTICIPATION CUE	● BOMB FALL LINE
3 LONG VECTORS	1 LONG VECTOR
● PULL-UP COMMAND	● WARNING INDICATOR
3 LONG VECTORS (1 BLANKED)	11 LONG VECTORS

Figure 6 presents an example of the display. On this display the trainer is diving to attack a ground target. The right-hand number indicates the target altitude of 5,000 feet. The right-hand bar height indicates the trainer altitude. The left-hand bar height indicates a trainer speed of 543 knots. This speed is above the 520 knot command indicated by the lines of the scale. The left-hand triangular pointer indicates a zero-velocity target. The long bomb fall line passing through the target marker indicates that the trainer is aligned in azimuth with the target. The solution cues are moving along the fall line to the target.

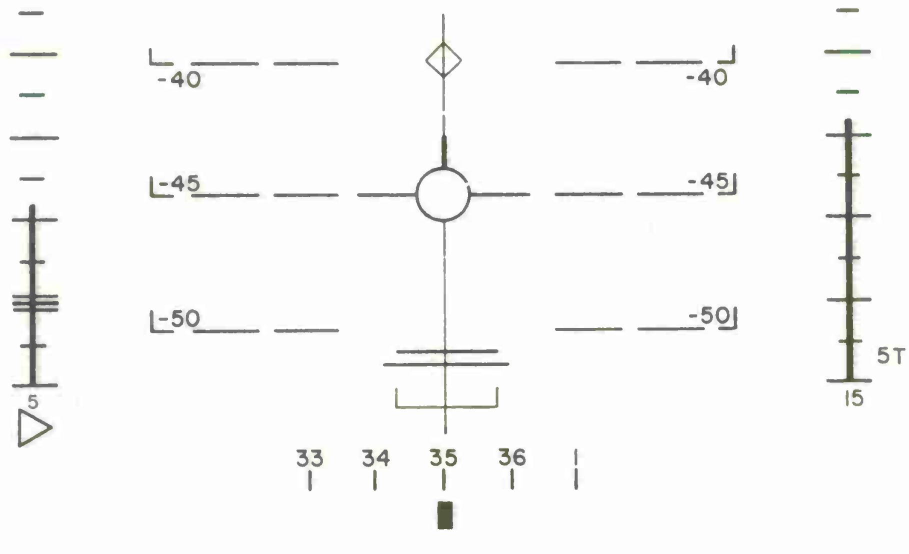


Figure 6. Attack Display

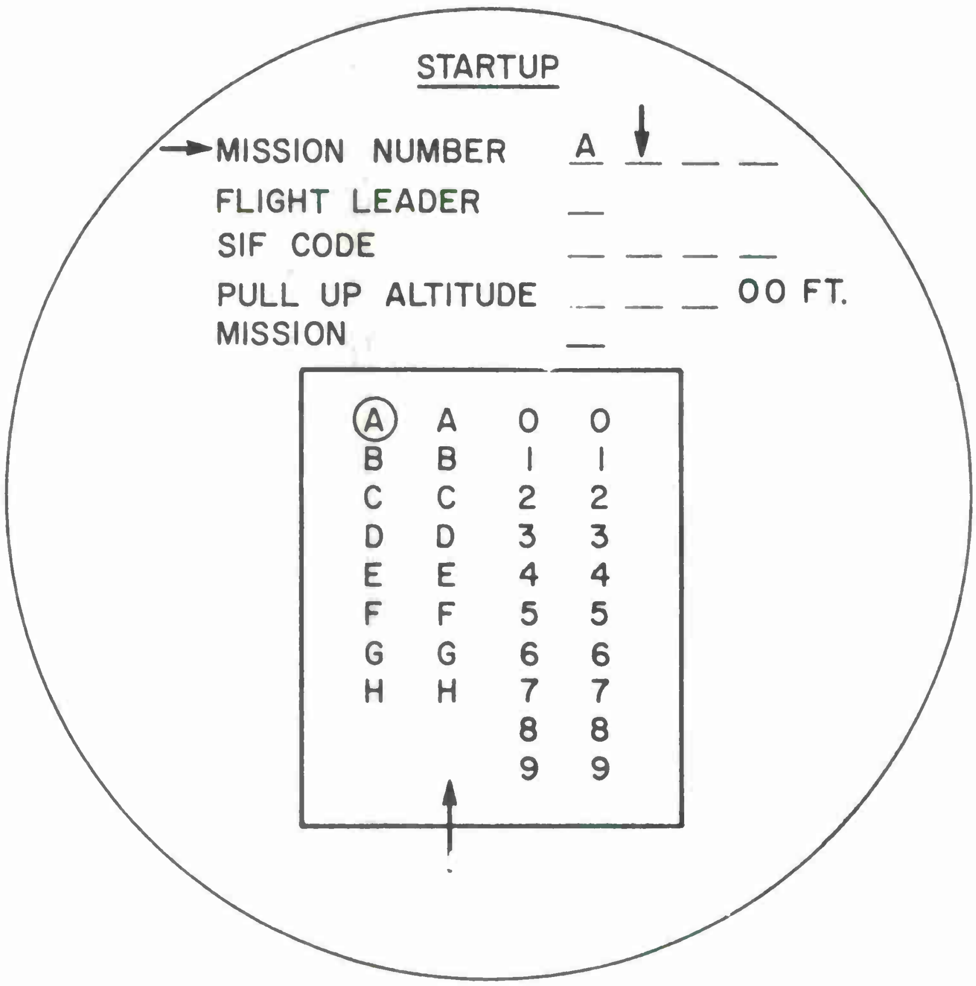


Figure 7. Startup Display

Startup Display

The Startup Display shall be addressable only to the Panel Display. It shall permit initializing stored values only while the Startup Program is running. It shall provide alphanumeric-key-images for character-by-character entry using the joystick. It shall provide cues and error indicators to guide the operator in insertions of data. No other displays shall be produced by the Startup Program.

The operator shall have the options to insert Mission Number-two alphabetic and two numeric characters, Flight Leader Designation-this trainer is the flight leader, SIF Code - four digit beacon code, Minimum Pull-Up Height - standard operating restriction for use during attack, and Mission - Tanker, Strike, Fighter, ECM, Reconnaissance, etc.

A typical display is shown in Figure 7. In this example, the pilot, prior to takeoff, is starting to enter his mission number. As indicated by the pointers, he is up to the second character of that line. He must choose from the second column of letters by using his joystick to position his cursor over a letter. After he presses the ENABLE button, the computer will read that letter, display it and position the pointers at the next entry. When he is ready to enter his mission, he will see a list of missions (Strike, Tanker, etc.) from which he is to select by using his joystick cursor.

Equipment Checkout Display

The Equipment Checkout Display shall be addressable to both the Panel Displays and Head-Up Displays. It shall present operator instructions, steering information and insertion cues to permit operator-computer interactive verification of the calibration of the trainer instruments and of the proper processing of flight data by the PDP-15. This display shall be the only graphic output of the Equipment Checkout Program.

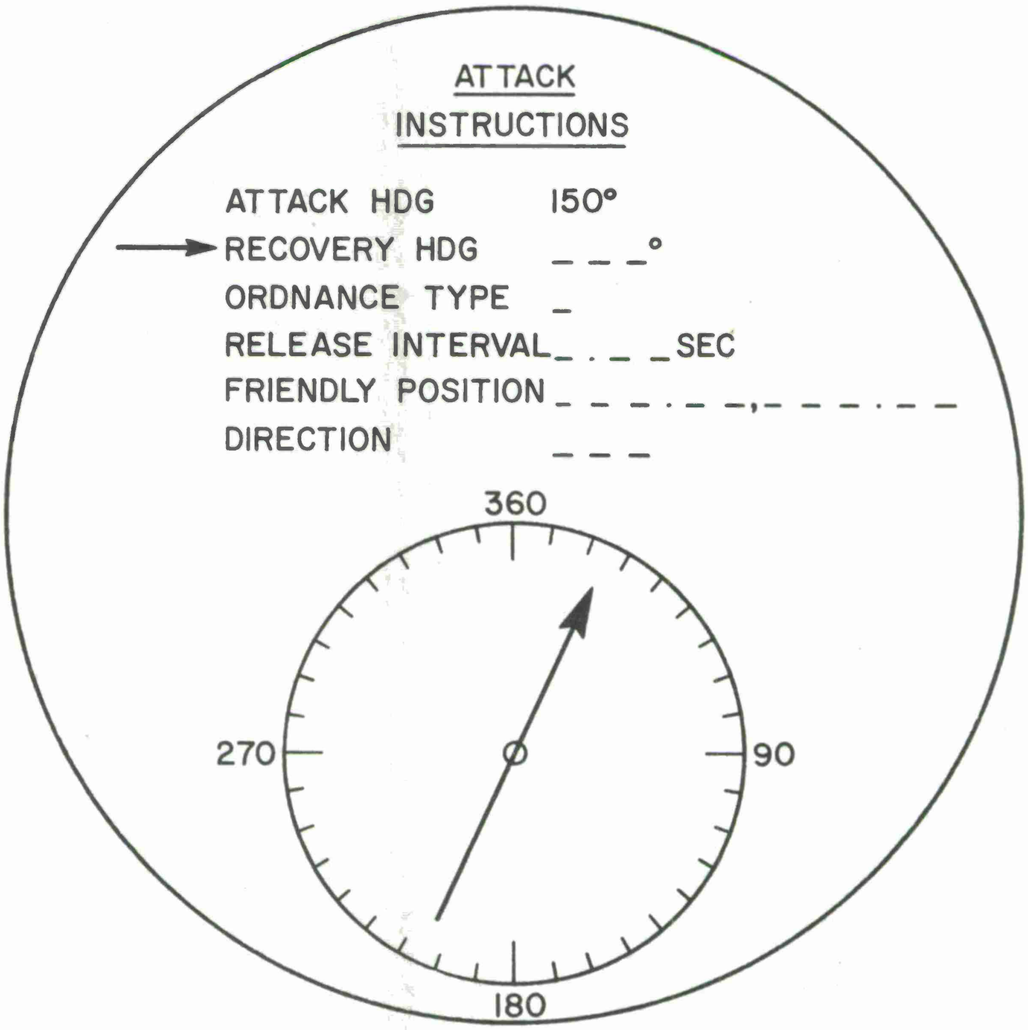


Figure 8. Message Cue Display

Steering information, as shown in the Navigation Display, shall appear on the Head-Up Display. All other information shall appear on the Panel Display.

AFAC Message Cue Display

The AFAC Message Cue Display shall be addressable only to the Panel Displays. It shall present message formats with options and cues for data entry to aid the AFAC in preparing his message outputs. Combined with the function switches it will serve as the AFAC special purpose message composer.

The display shall present a format for the operator-selected message including headers, blanks, and filled-in characters; lists of options for the operator to select by joystick; and alphanumeric-key-images for character-by-character insertion by joystick.

The operator shall have the options of choosing formats, entering items, deleting items, re-positioning the pointer, and accepting the final message for transmission.

An example of the display is shown in Figure 8. In this display the AFAC is preparing an Attack Instructions message. He has entered the recommended attack heading and is about to suggest a recovery heading. His display presents a compass rose. With his cursor he can drag the displayed pointer to the heading he desires and activate its switch. The desired heading then will appear in the completed message. When he goes to the next item, ordnance, he will be shown a list of types which he could select with his cursor. If the message is completed to his satisfaction, a final activation will send it.

SWITCH INPUTS

Sixteen push buttons mounted in a 4 button by 4 button matrix in each trainer shall provide the capability to control displays and filter messages; and in conjunction with the joystick and panel display, select text and enter position data. Upon receipt of an interrupt from an ENABLE button, the computer program shall read the input buffer with the 16 bits representing the on-off status of the 16 function switches. These values shall be checked to determine if they match the pattern of a valid switch input. If so, they shall be stored prior to further processing and an output signal shall be sent to release the switch holding coils. If not, an output signal shall be sent to both the holding coil release and to an ERROR lamp. The ERROR lamp shall remain lit until the next switch action is enabled.

Switch Module Normal Lighting

TEXT DISPLAY	OWN MISSION	SILENT	TOSS BOMB	STRIKE/ SUPPORT REQUEST	WEAPON I	RENDEZ-VOUS
	NAVIGATION DISPLAY		JOYSTICK CENTER	ASSIGNMENT	FULL SUCCESS	X2 EXPAND
SITUATION DISPLAY	ALL FRIENDLY	ON DEMAND	LAYDOWN/ DIVE BOMB	FRIENDLY FORCE REPORT	WEAPON II	AIR-GROUND
	ATTACK DISPLAY		OWN AIRCRAFT AT CENTER	EMERGENCY STATUS	PART SUCCESS	X4 EXPAND
ACCEPT/ ACKNOWLEDGE	AIR HOSTILE		MANUAL RELEASE	POST STRIKE REPORT	WEAPON III	AIR-AIR
	REPORT		ASSIGNED TARGET AT CENTER	WEAPONS STATUS	FAILURE	X16 EXPAND
REJECT/CLEAR	GROUND HOSTILE		AUTO RELEASE	GROUND TARGET REPORT		
	NORTH UP	DOWN PILOT	DESTINATION AT CENTER	POSITION	ABORT	DECLUTTER

Figure 9A

Switch Designations

Ø	4	8	12
1	5	9	13
2	6	10	14
3	7	11	15

Figure 9B

Button Sections

B	A
C	D

Figure 9C

Reading of switch insertions shall be in response to an interrupt designating the module to be serviced. Processing of inputs shall be on a periodic basis in response to control subroutine incrementing of sequence parameters.

Figure 9 shows a push button module. In Figure 9A those buttons which will normally be illuminated in color are shown as shaded areas. Multicolor light cues will be used to avoid a confusing clutter of labels by indicating the options available for each switch action, when an illuminated button is pressed. For example, if the pilot requests navigation to a tanker rendezvous he will press the NAVIGATION button. This will light only the three options available. He will then press the RENDEZVOUS option button, position the joystick cursor over the tanker symbol and press ENABLE to notify the computer. If the action is not correct, an error lamp will be lit by the computer. Figure 9B shows the designation of the buttons. Each button will be wired to the corresponding digital input of a sensing switch input module. Switch Ø will be read into bit Ø of its module's input word, switch 1 into bit 1, etc. up to switch 15 which will be read into bit 15. Bits 16 and 17 will be unused. The switch inputs function shall consider the binary configurations of bits 0-15 as the input switch patterns for purposes of validation by comparison with its stored patterns. Figure 9C shows the designation of sections on each switch button. Although the computer does not recognize subdivision of a single button, separate illumination of each section will serve as a cue to guide the pilot in his choice of buttons for insertions.

Each valid switch action is described in a section below. Insertions and results shall be as outlined in Table VII on pages 24 through 27. Buttons specified for SWITCH INSERTIONS in this table are identified using the switch and section designations shown in Figure 9. The displayed information with which the joystick cursor will be aligned for the insertions is identified in the JOYSTICK column. If the ENABLE button can be used to signal the ENTRY of an input, the JOYSTICK column is blank and the position which the Switch Inputs function shall assume is that shown in the COMMENTS column. For example, if a button enable were used instead of a joystick enable for the Ground Target Location Report, the Switch Inputs function would assume that the ground target's location is coincident with the ground projection of the trainer's location. If instead, the pilot had enabled the joystick, the location of its cursor would have been considered as the ground target location. The ENTRY column indicates either joystick enable, designated by J, or button enable, designated by B. The displayed information with which the joystick cursor is to be aligned has been indicated by:

P = Pilot Position	C = Chosen Display Center
N = Next Location	D = Display Message Item
T = Target Position	S = Selected Line or Item

TABLE VII

SWITCH ACTION MATRIX

TITLE	INPUTS: SWITCH INSERTIONS					INPUTS: JOY-STICK	INPUTS: ENTRY	DISPLAYS	FUNCTIONS	COMMENTS
Rendezvous Guidance	4CD	12A				T,-	J,B*	Navigation	Navigation	*Destination = assigned. Tactic = stern.
Ground Target Guidance	4CD	13A				T,-	J,B*	Navigation, Attack	Navigation, Attack	*Destination = assigned. Air-to-Ground Attack calculations start at destination. Destination is 10 miles out from target, along attack heading.
Air Target Guidance	4CD	14A				T,-	J,B*	Navigation	Navigation	*Destination = assigned.
Attack	5CD	8B 9B	12B, 13B, 14B	10B 11B		T,-	J,B*	Attack	Attack	*Target = assigned. If no options: mode = laydown, release = auto, weapon = I
Situation Display Selection	1	8C, 9C, 10C, 11C	7C	12D, 13D, 14D	15D	C,-	J,B	Situation	--	If no options: center = trainer, expansion = X1, orientation = heading up, declutter = no
Situation Display Content	1 2,3	4AB, 5AB, 6AB, 7AB				-	B	Situation	--	--
Radio Silent Mode	6CD	4A				-	B	--	Disables Message Output	--

TABLE VII

SWITCH ACTION MATRIX

(CONTINUED)

TITLE	INPUTS							DISPLAYS	FUNCTIONS	COMMENTS
	SWITCH INSERTIONS					JOY-STICK	ENTRY			
Downed Pilot Report	6CD	7CD				P,-	J,B*	--	Message Output	*Location = trainer location
Post Strike Mission Results Report	6CD	10A	12C, 13C, 14C, 15C			T,-	J,B*	--	Message Output	*Location = trainer location
Friendly Force Location Report	6CD	9A				T,-	J,B*	--	Message Output	*Location = trainer location
Ground Target Location Report	6CD	11A				T,-	J,B*	--	Message Output	*Location = trainer location
Strike-Support Request	6CD	8A				T,-	J,B*	--	Message Output	*Location = trainer location
Emergency Status	9A					-	B	--	Message Output	Sets Emergency Status in trainer Position-Status Report
Filter	2,3	4AB, 5AB, 6AB, 7AB,	8D, 9D, 10D, 11D			-	B	--	--	Sets filter criteria for message input function

TABLE VII

SWITCH ACTION MATRIX

(CONTINUED)

TITLE	INPUTS							DISPLAYS	FUNCTIONS	COMMENTS
	SWITCH INSERTIONS					JOY-STICK	ENTRY			
Acknowledge	2,3	8D				T,-	J,B*	Clears Acknowledge Lamp	Message Output	--
Text	Ø					S,-	J,B*	Text	--	*Calls up alternate text pages
AFAC Pointer Move		12AB				N	J	--	--	Pointer moves to cursor position
AFAC Entry	2	13AB				S	J	--	--	Enters or deletes selected entry
AFAC Options	2,3	14AB				S	J	--	--	Displays options for selected item
AFAC Message Accept	2	15AB				-	B	--	Message Output	Sends message composed by AFAC
Offset Point Cues	5CD					D	J	Offset Point Message	Message Output	--
Attack Instructions Cues	6CD					D	J	Attack Instructions Message	Message Output	--
Downed Pilot Cues	7CD					D	J	Downed Pilot Report	Message Output	--
Strike Request Cues	8A					D	J	Strike Request	Message Output	--

TABLE VII

SWITCH ACTION MATRIX
(CONCLUDED)

TITLE	INPUTS							DISPLAYS	FUNCTIONS	COMMENTS
	SWITCH INSERTIONS					JOY-STICK	ENTRY			
Friendly Force Position Cues	9A					D	J	Friendly Force Report	Message Output	--
Post Strike Results Cues	10A					D	J	Post Strike Report	Message Output	--
Ground Target Positions Cue	11A					D	J	Ground Target Report	Message Output	--
Air-to-Air Weapon Firing	14*					-	*	--	--	*Trainer control stick switch simulates this insertion and ENABLE.
Manual Bomb Release	13*					-	*	--	--	*Trainer control stick switch simulates this insertion and ENABLE. This action overrides automatic bomb release.
Transmit on Demand	6CD	5A				-	B	--	Disables Message Output	Message output only in response to input message requesting transmission.

Navigation Switch Actions

The Navigation switch actions shall call the Navigation Display and permit entry of the mission and location to which vectoring is required. Options are shown in Figure 10.

<table>
<tr><td rowspan="2">TEXT DISPLAY</td><td>OWN MISSION</td><td>SILENT</td><td>TOSS BOMB</td><td>STRIKE/ SUPPORT REQUEST</td><td>WEAPON I</td><td>RENDEZ-VOUS</td></tr>
<tr><td colspan="2">NAVIGATION DISPLAY</td><td>JOYSTICK CENTER</td><td>ASSIGNMENT</td><td>FULL SUCCESS</td><td>X2 EXPAND</td></tr>
<tr><td rowspan="2">SITUATION DISPLAY</td><td>ALL FRIENDLY</td><td>ON DEMAND</td><td>LAYDOWN/ DIVE BOMB</td><td>FRIENDLY FORCE REPORT</td><td>WEAPON II</td><td>AIR-GROUND</td></tr>
<tr><td colspan="2">ATTACK DISPLAY</td><td>OWN AIRCRAFT AT CENTER</td><td>EMERGENCY STATUS</td><td>PART SUCCESS</td><td>X4 EXPAND</td></tr>
<tr><td rowspan="2">ACCEPT/ ACKNOWLEDGE</td><td colspan="2">AIR HOSTILE</td><td>MANUAL RELEASE</td><td>POST STRIKE REPORT</td><td>WEAPON III</td><td>AIR-AIR</td></tr>
<tr><td colspan="2">REPORT</td><td>ASSIGNED TARGET AT CENTER</td><td>WEAPONS STATUS</td><td>FAILURE</td><td>X16 EXPAND</td></tr>
<tr><td rowspan="2">REJECT/CLEAR</td><td colspan="2">GROUND HOSTILE</td><td>AUTO RELEASE</td><td>GROUND TARGET REPORT</td><td colspan="2"></td></tr>
<tr><td>NORTH UP</td><td>DOWN PILOT</td><td>DESTINATION AT CENTER</td><td>POSITION</td><td>ABORT</td><td>DECLUTTER</td></tr>
</table>

Figure 10. Navigation Switches

Attack Switch Actions

The Attack switch actions shall call the Attack Display and permit entry of bombing mode, weapon and release mode. Options are shown in Figure 11.

<table>
<tr><td rowspan="2">TEXT DISPLAY</td><td>OWN MISSION</td><td>SILENT</td><td>TOSS BOMB</td><td>STRIKE/ SUPPORT REQUEST</td><td>WEAPON I</td><td>RENDEZ-VOUS</td></tr>
<tr><td colspan="2">NAVIGATION DISPLAY</td><td>JOYSTICK CENTER</td><td>ASSIGNMENT</td><td>FULL SUCCESS</td><td>X2 EXPAND</td></tr>
<tr><td rowspan="2">SITUATION DISPLAY</td><td>ALL FRIENDLY</td><td>ON DEMAND</td><td>LAYDOWN/ DIVE BOMB</td><td>FRIENDLY FORCE REPORT</td><td>WEAPON II</td><td>AIR-GROUND</td></tr>
<tr><td colspan="2">ATTACK DISPLAY</td><td>OWN AIRCRAFT AT CENTER</td><td>EMERGENCY STATUS</td><td>PART SUCCESS</td><td>X4 EXPAND</td></tr>
<tr><td rowspan="2">ACCEPT/ ACKNOWLEDGE</td><td colspan="2">AIR HOSTILE</td><td>MANUAL RELEASE</td><td>POST STRIKE REPORT</td><td>WEAPON III</td><td>AIR-AIR</td></tr>
<tr><td colspan="2">REPORT</td><td>ASSIGNED TARGET AT CENTER</td><td>WEAPONS STATUS</td><td>FAILURE</td><td>X16 EXPAND</td></tr>
<tr><td rowspan="2">REJECT/CLEAR</td><td colspan="2">GROUND HOSTILE</td><td>AUTO RELEASE</td><td>GROUND TARGET REPORT</td><td colspan="2"></td></tr>
<tr><td>NORTH UP</td><td>DOWN PILOT</td><td>DESTINATION AT CENTER</td><td>POSITION</td><td>ABORT</td><td>DECLUTTER</td></tr>
</table>

Figure 11. Attack Switches

Display Switch Actions

The Display switch actions shall permit the operator to choose the scale, orientation, content and center of his situation display on the panel display surface. Options are shown in Figure 12.

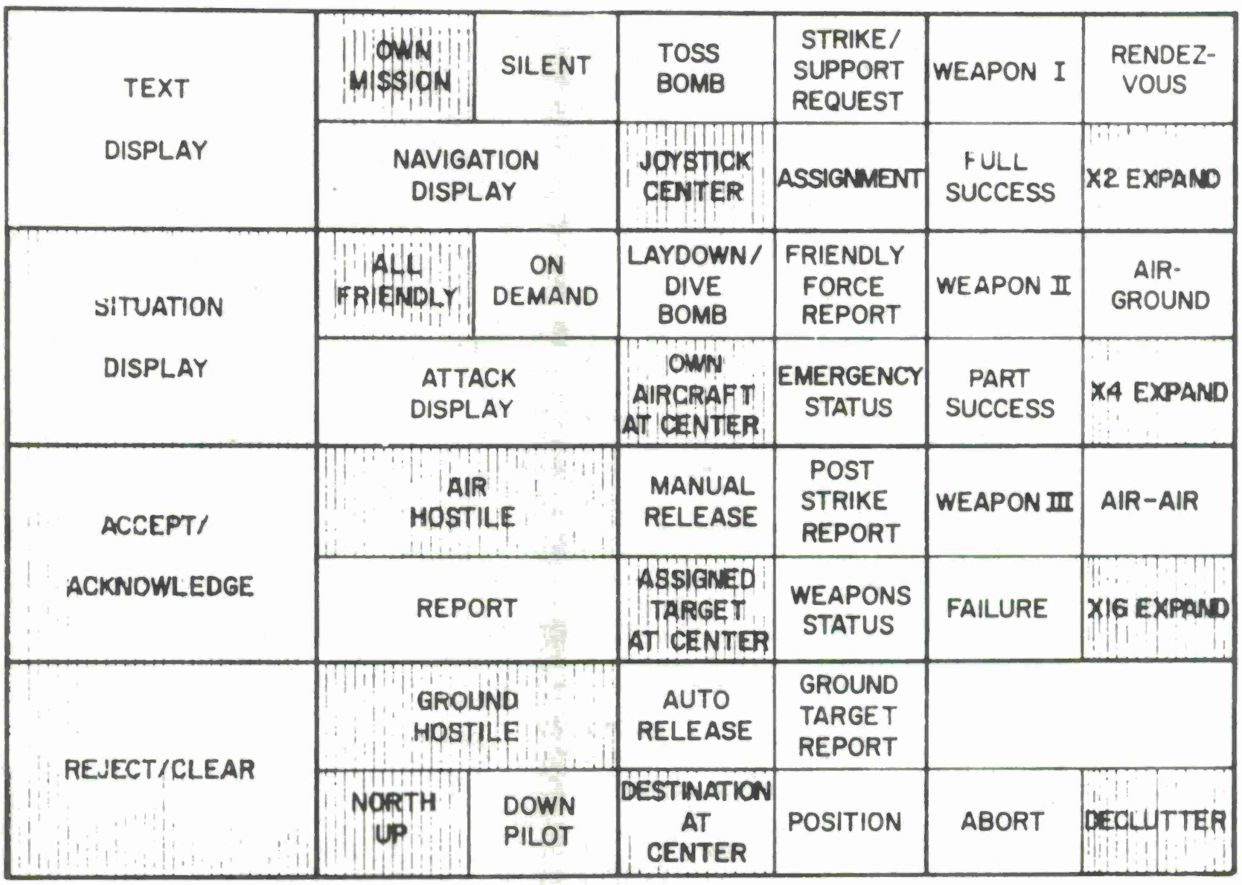


Figure 12. Display Switches

Reporting Switch Actions

The Reporting switch actions shall permit the operator to send messages to the PLRACTA network. Options are shown in Figure 13.

TEXT DISPLAY	OWN MISSION	SILENT	TOSS BOMB	STRIKE/ SUPPORT REQUEST	WEAPON I	RENDEZ-VOUS
	NAVIGATION DISPLAY		JOYSTICK CENTER	ASSIGNMENT	FULL SUCCESS	X2 EXPAND
SITUATION DISPLAY	ALL FRIENDLY	ON DEMAND	LAYDOWN/ DIVE BOMB	FRIENDLY FORCE REPORT	WEAPON II	AIR-GROUND
	ATTACK DISPLAY		OWN AIRCRAFT AT CENTER	EMERGENCY STATUS	PART SUCCESS	X4 EXPAND
ACCEPT/ ACKNOWLEDGE	AIR HOSTILE		MANUAL RELEASE	POST STRIKE REPORT	WEAPON III	AIR-AIR
	REPORT		ASSIGNED TARGET AT CENTER	WEAPONS STATUS	FAILURE	XI6 EXPAND
REJECT/CLEAR	GROUND HOSTILE		AUTO RELEASE	GROUND TARGET REPORT		
	NORTH UP	DOWN PILOT	DESTINATION AT CENTER	POSITION	ABORT	DECLUTTER

Figure 13. Reporting Switches

Filtering Switch Actions

The Filtering switch actions shall permit the operator to select the addresses or class track to be accepted into his system and to specify the type of information to be permitted. Options are shown in Figure 14.

TEXT DISPLAY	OWN MISSION	SILENT	TOSS BOMB	STRIKE/ SUPPORT REQUEST	WEAPON I	RENDEZ-VOUS
	NAVIGATION DISPLAY		JOYSTICK CENTER	ASSIGNMENT	FULL SUCCESS	X2 EXPAND
SITUATION DISPLAY	ALL FRIENDLY	ON DEMAND	LAYDOWN/ DIVE BOMB	FRIENDLY FORCE REPORT	WEAPON II	AIR-GROUND
	ATTACK DISPLAY		OWN AIRCRAFT AT CENTER	EMERGENCY STATUS	PART SUCCESS	X4 EXPAND
ACCEPT/ ACKNOWLEDGE	AIR HOSTILE		MANUAL RELEASE	POST STRIKE REPORT	WEAPON III	AIR-AIR
	REPORT		ASSIGNED TARGET AT CENTER	WEAPONS STATUS	FAILURE	X16 EXPAND
REJECT/CLEAR	GROUND HOSTILE		AUTO RELEASE	GROUND TARGET REPORT		
	NORTH UP	DOWN PILOT	DESTINATION AT CENTER	POSITION	ABORT	DECLUTTER

Figure 14. Message Filter Switches

Acknowledgement Switch Actions

The Acknowledgement switch actions shall permit the operator to generate an acknowledgement message when requested and to accept or reject an assignment message. Options are shown in Figure 15.

TEXT DISPLAY	OWN MISSION	SILENT	TOSS BOMB	STRIKE/ SUPPORT REQUEST	WEAPON I	RENDEZ-VOUS
	NAVIGATION DISPLAY		JOYSTICK CENTER	ASSIGNMENT	FULL SUCCESS	X2 EXPAND
SITUATION DISPLAY	ALL FRIENDLY	ON DEMAND	LAYDOWN/ DIVE BOMB	FRIENDLY FORCE REPORT	WEAPON II	AIR-GROUND
	ATTACK DISPLAY		OWN AIRCRAFT AT CENTER	EMERGENCY STATUS	PART SUCCESS	X4 EXPAND
ACCEPT/ ACKNOWLEDGE	AIR HOSTILE		MANUAL RELEASE	POST STRIKE REPORT	WEAPON III	AIR-AIR
	REPORT		ASSIGNED TARGET AT CENTER	WEAPONS STATUS	FAILURE	X16 EXPAND
REJECT/CLEAR	GROUND HOSTILE		AUTO RELEASE	GROUND TARGET REPORT		
	NORTH UP	DOWN PILOT	DESTINATION AT CENTER	POSITION	ABORT	DECLUTTER

Figure 15. Acknowledgement Switches

AFAC Message Cues Switch Actions

The AFAC Message Cues switch actions shall permit the AFAC to select any of his messages for format viewing and for insertion, by joystick selection, of the options or key-images available for each item.

The normal illumination of the AFAC switch module will be as shown in Figure 16. Insertion of the button for any report identified on the panel shall cause the display of the corresponding message format after the ENABLE switch has been read.

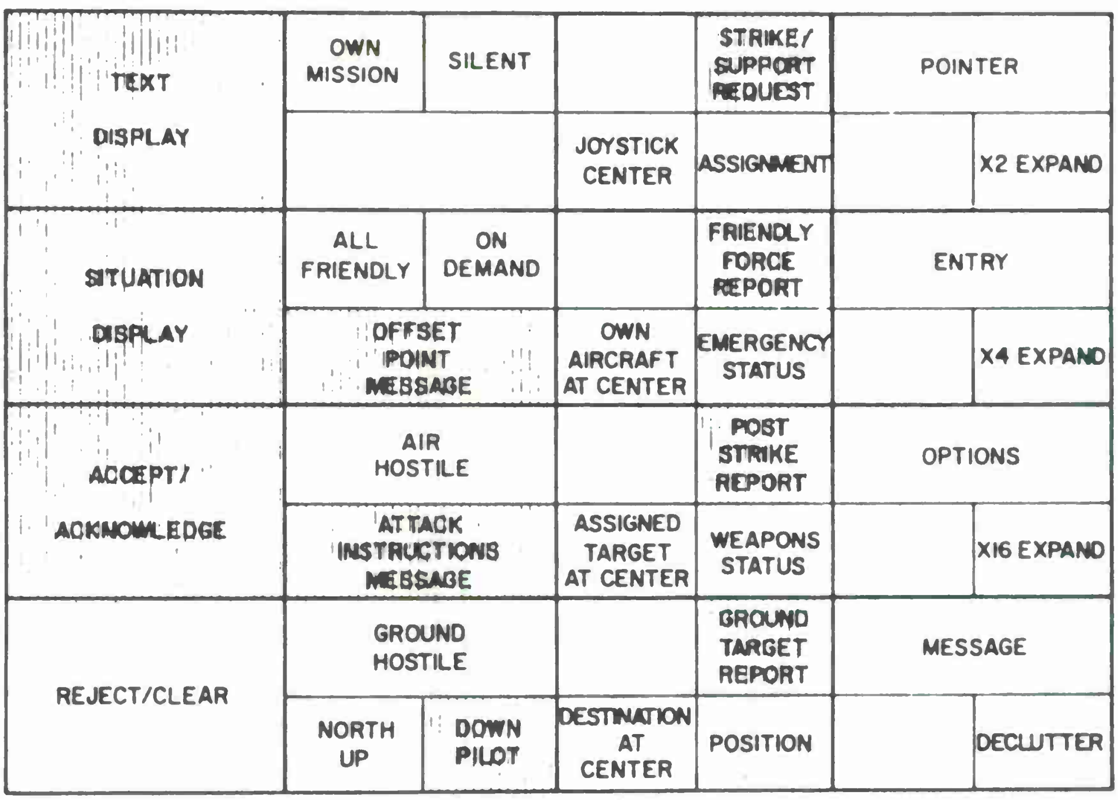


Figure 16. AFAC Switch Module Normal Lighting

Text Switch Action

The Text switch action shall permit the operator to select pages of text for display on the Panel Display and to select any item on a page and display its expanded information. This action is shown in Figure 17.

<table>
<tr><td rowspan="2">TEXT DISPLAY</td><td>OWN MISSION</td><td>SILENT</td><td>TOSS BOMB</td><td>STRIKE/ SUPPORT REQUEST</td><td>WEAPON I</td><td>RENDEZ-VOUS</td></tr>
<tr><td colspan="2">NAVIGATION DISPLAY</td><td>JOYSTICK CENTER</td><td>ASSIGNMENT</td><td>FULL SUCCESS</td><td>X2 EXPAND</td></tr>
<tr><td rowspan="2">SITUATION DISPLAY</td><td>ALL FRIENDLY</td><td>ON DEMAND</td><td>LAYDOWN/ DIVE BOMB</td><td>FRIENDLY FORCE REPORT</td><td>WEAPON II</td><td>AIR-GROUND</td></tr>
<tr><td colspan="2">ATTACK DISPLAY</td><td>OWN AIRCRAFT AT CENTER</td><td>EMERGENCY STATUS</td><td>PART SUCCESS</td><td>X4 EXPAND</td></tr>
<tr><td rowspan="2">ACCEPT/ ACKNOWLEDGE</td><td colspan="2">AIR HOSTILE</td><td>MANUAL RELEASE</td><td>POST STRIKE REPORT</td><td>WEAPON III</td><td>AIR-AIR</td></tr>
<tr><td colspan="2">REPORT</td><td>ASSIGNED TARGET AT CENTER</td><td>WEAPONS STATUS</td><td>FAILURE</td><td>X16 EXPAND</td></tr>
<tr><td rowspan="2">REJECT/CLEAR</td><td colspan="2">GROUND HOSTILE</td><td>AUTO RELEASE</td><td>GROUND TARGET REPORT</td><td colspan="2"></td></tr>
<tr><td>NORTH UP</td><td>DOWN PILOT</td><td>DESTINATION AT CENTER</td><td>POSITION</td><td>ABORT</td><td>DECLUTTER</td></tr>
</table>

Figure 17. Text Display Switch

SIMULATION INPUT PROCESSING

The Simulation Input Processing function shall permit initialization of items and input of new values during program operation. Input of identifiers for any items, new values for those items, and the time at which the values are to change, shall be accepted from magnetic tape or punched paper tape. Data shall be read from the input into a buffer once every ten seconds. Data in the input buffer shall be inserted into the central tables at individually selectable rates ranging from ten times per second to once per five hours. A "Parameter Test mode" shall be provided for use during program checkout. In this mode multiple sets of inputs shall be read in with system operation for each set. Halting of the current operation and input of the next set shall be in response to operator insertions of prespecified conditions.

RECORDING

The Recording function shall accept lists of items to be recorded identifying the name, absolute location or relative location of the item or table to be recorded, the time at which recording is to be performed or the name of the program after which recording is to be performed. It shall prepare output records; label those records with the time of recording and a unique identifier; and write those records onto magnetic tape.

NAVIGATION

The Navigation function shall provide the capability to perform coordinate conversions; select tactics; compute command information for display; test for acceptable solutions; and test for impossible solutions, as described below.

The pilot shall have the option of selecting the Navigation Display, specifying the mission and designating the target or destination, as described in the Display and Switch Inputs function sections.

Coordinate Conversion

The Navigation function shall perform the coordinate transformations required. The trainer and target or destination shall first be transformed into an orthogonal grid coordinate system. The second transformation shall be to a trainer-centered system with axes parallel to grid axes. The third transformation shall be used for the lead collision portion of the computations. To permit the final position of the trainer and its target or destination to be offset by a chosen distance, the target or destination position shall be extended forward by the lead distance. For computational purposes the target or destination shall be considered as being at the extended location, the "virtual coordinates". In addition corrections to the trainer position shall be made for time to be spent in accelerations, decelerations, climbs, descents and armament travel. The fourth transformation shall be used to displace the trainer position by the radius of the initial and final turns.

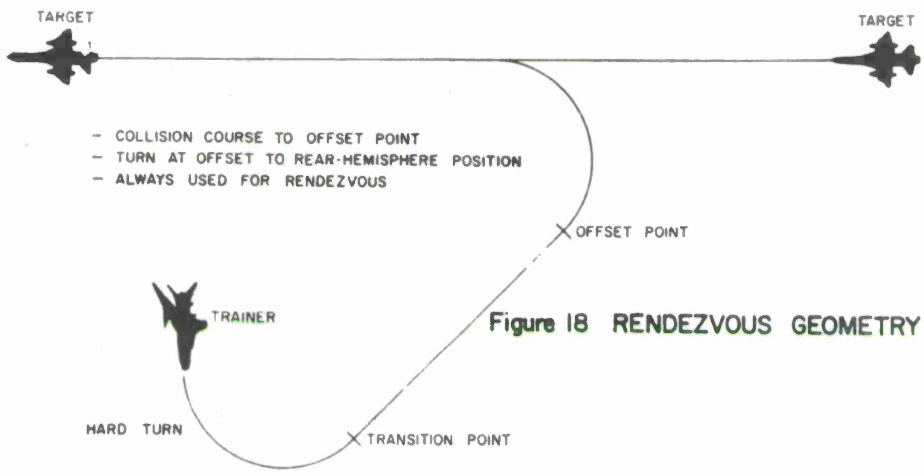


Figure 18 RENDEZVOUS GEOMETRY

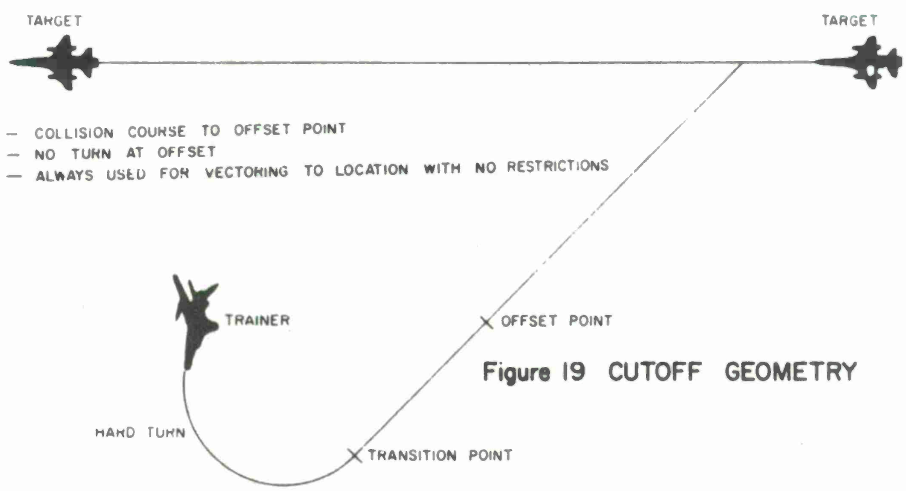


Figure 19 CUTOFF GEOMETRY

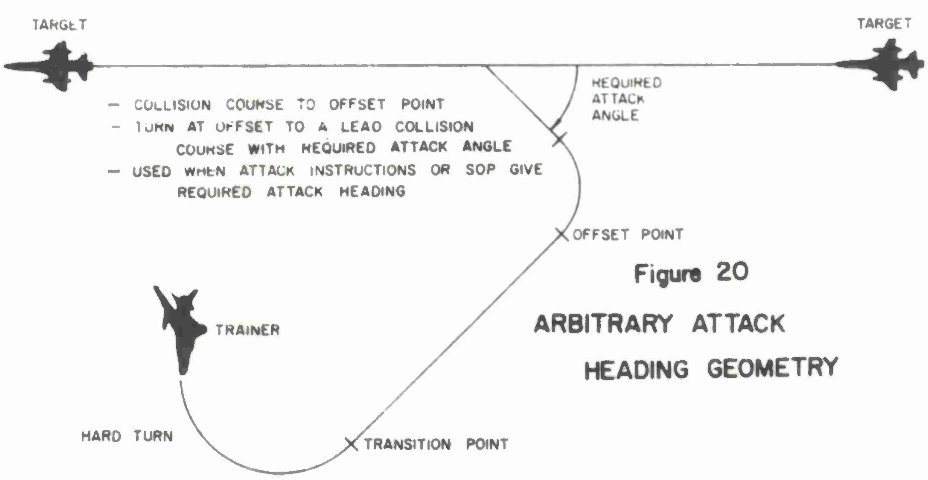


Figure 20

ARBITRARY ATTACK HEADING GEOMETRY

Tactic Selection

Using the pilot's insertion of RENDEZVOUS or AIR-TO-AIR or AIR-TO-GROUND by push button, the Navigation function shall choose the approach tactic for use in navigation calculations. The RENDEZVOUS option shall always cause the choice of the Stern approach tactic. AIR-TO-AIR or AIR-TO-GROUND options shall cause the choice of the Cutoff tactic unless restrictions or attack instructions have been specified. In that case, the function shall choose the Arbitrary Heading tactic, using the prespecified heading. These tactics shall be as shown in Figures 18, 19 and 20.

Command Information

This portion of the Navigation function shall prepare command heading, command altitude, and command speed for displays to permit navigation to fixed ground targets, moving ground targets, friendly aircraft or hostile aircraft. The calculations shall consider the selected tactic, the trainers' flight characteristics, position, altitude, heading, and speed and the target's or destination's position, altitude, heading and speed as provided by the PLRACTA network, in accordance with Table VIII.

TABLE VIII

DATA REQUIRED FOR NAVIGATION

Z_T	=	Target Altitude
V_T	=	Target Speed
ψ_T	=	Target Heading
X_T, Y_T	=	Target Location
$\dot{X}_T$, $\dot{Y}_T$	=	Target Speed Components
X_1, Y_1	=	Target Location in Trainer-Centered Coordinates
V_A	=	Trainer Speed
ψ_A	=	Trainer Heading
X_A, Y_A	=	Trainer Location
$\dot{X}_A$, $\dot{Y}_A$	=	Trainer Speed Components
$V_{A\ MAX}$	=	Trainer Maximum Speed
θ_b	=	Trainer Bank Angle
V_1	=	Velocity during Initial Turn
V_2	=	Velocity during Final Turn
e_1	=	Direction of Initial Turn
e_2	=	Direction of Final Turn
R_1	=	Radius of Initial Turn
R_2	=	Radius of Final Turn
Z_o	=	Altitude for Optimum Cruise
θ_E	=	Extremes of Miss Distance Function
d_1, d_2, d_3, d_4	=	Miss Distance Factors
T_c	=	Time in Climb/Descent
D_c	=	Horizontal Distance in Climb
T_A	=	Acceleration/Deceleration Time
a,b	=	Armament Constants
θ_{COMD}	=	Command Heading
θ_{ATTACK}	=	Attack Heading
g	=	Gravitational Constant
Z_2	=	Combat Altitude
D_j	=	Separation before Attack
V_k	=	Velocity used in Computations
ΔT_v	=	Total Time in Maneuvers and Armament Travel
ΔT_{c1}	=	Time to Climb to Command Altitude
ΔT_{A1}	=	Time to Accelerate to Cruise Speed
ΔT_{A2}	=	Time to Accelerate to Combat Speed
ΔT_{c2}	=	Time to Climb or Descend to Combat Altitude
T_{ARM}	=	Armament Travel Time
F	=	Armament Travel Distance
X_3, Y_3	=	Trainer Location in Virtual Target-Centered Coordinates
ϕ	=	Approach Angle during Attack
θ_P	=	Miss Distance Subinterval
d_{mi}	=	Value of Miss Distance at Heading Angle θ_i
k	=	Miss Distance Test Constant
σ	=	Side of Attack Indicator
X_4, Y_4	=	Trainer Location in Displaced Virtual Target-Centered Coordinates
ρ_k	=	Speed Ratio
T_T	=	Time in Turns
θ	=	Current Command Heading
d_c	=	Turn Circle Separation
d_m	=	Miss Distance
TTG	=	Time-To-Go till Virtual Target is reached
T_{js}	=	Time to Travel during Attack Leg Straight Path
T_p	=	Time of Current Minimum Solution
X_c, Y_c	=	Location of Interdiction or Rendezvous Point
F_{RES}	=	Fuel Reserve after Interdiction or Rendezvous
F_{OB}	=	Fuel-On-Board
F_I	=	Fuel Required to Reach Interdiction Point
T_A	=	Time on Attack Leg
T_{c12}	=	Time in Climb from Present Altitude to Combat Altitude
F_{c12}	=	Fuel to Climb from Present Altitude to Combat Altitude
$\dot{F}_{V22}$	=	Level Flight Fuel Consumption Rate for V_2 at Z_2
$\dot{F}_{V1o}$	=	Level Flight Fuel Consumption Rate for V_1 at Z_o
T_B	=	Time between Turns
ρ_{c1}	=	Relative Closing Velocity

Selection of the AIR-TO-GROUND option shall cause calculations of command information to be made with respect to a destination displaced from the actual target location by ten miles toward the trainer along the attack heading vector. When the trainer reaches that destination the Navigation function shall cease to operate and the Air-to-Ground Attack function shall begin to operate.

The Navigation function shall monitor the trainer position with respect to preset border and warning areas. If a trainer approaches within a preset buffer distance from these areas, a unique alarm indication shall be generated. The alarm indication shall remain until the trainer is again outside the buffer distance.

The Navigation function shall determine vectoring in accordance with the Navigation equations given in Table IX, pages 44 through 53. If commands are received from the PLRACTA network in Intercept Flight Direction and Control messages, these commands shall be stored and displayed instead of computed values.

TABLE IX

NAVIGATION EQUATIONS

PRELIMINARY IMPOSSIBLE TEST

IMPOSSIBLE IF $$\frac{V_T}{V_{MAX}} > .9$$

RADIUS OF INITIAL TURN $$R_1 = \frac{V_1^{\,2} \cot\theta_b}{g}$$

RADIUS OF FINAL TURN $$R_2 = \frac{V_2^{\,2} \cot\theta_b}{g}$$

TRANSFORMATION OF TARGET TO TRAINER-CENTERED COORDINATES

$$X_1 = X_T - X_A$$

$$Y_1 = Y_T - Y_A$$

RANGE FROM TARGET TO TRAINER $$R = \sqrt{X_1^{\,2} + Y_1^{\,2}}$$

TABLE IX (CONTINUED)

BEARING $\psi = \left| \psi_A - \psi_T \right|$

IF $\psi_A > \psi_T$ TARGET IS TO BE STARBOARD

$\psi_A < \psi_T$ TARGET IS TO BE PORT

TRANSFORMATION TO VIRTUAL TARGET-CENTERED COORDINATES

$$X_3 = \left(Y_1 \sin \psi_T - X_1 \cos \psi_T \right) + D_j \sin \theta_{ATTACK}$$

$$Y_3 = \left(-X_1 \sin \psi_T - Y_1 \cos \psi_T \right) + D_j \cos \theta_{ATTACK} - \Delta T_v \cdot V_T$$

$V_k = V_1$ TRANSITION

V_2 POST TRANSITION

$$\Delta T_v = T_c + \Delta T_{A1} + \Delta T_{A2} + \Delta T_{c2} + T_{ARM}$$

$$\Delta T_{c1} = \Delta T_{c1} - \frac{D_{c1}}{V_T}$$

$$\Delta T_{A1} = T_{A1} - T_{A1} \left(\frac{V_T + V_1}{2V_1} \right)$$

TABLE IX (CONTINUED)

$$\Delta T_{A2} = T_{A2} - T_{A2}\left(\frac{V_T + V_2}{2V_k}\right)$$

$$\Delta T_{c2} = T_{c2} - T_{c2}\ \frac{V_2}{V_k}$$

$$T_{ARM} = \frac{F}{V_2}$$

$$F = aZ_T + b$$

SECONDARY IMPOSSIBLE TEST

IMPOSSIBLE IF $\frac{V_T}{V_k} \geq 0.97$ AND $Y_3 < 0$, $\frac{V_T}{V_k} > 1.2$ AND $Y_3 \geq 0$

V_k = COMMAND SPEED

COMMAND HEADING $\theta_{COMD} = \text{ARC TAN}\left(\frac{-X_3}{-Y_3}\right)$

ATTACK HEADING $\theta_{ATTACK} = -\sigma\phi + \psi_T$

SIDE INDICATOR

$\sigma = +1$ IF $X_T > X_A$

$= -1$ IF $X_T \leq X_A$

TABLE IX (CONTINUED)

TRANSFORMATION TO DISPLACED VIRTUAL COORDINATES

$$X_4 = X_3 + e_1R_1 \cos \theta_A - e_2R_2 \cos \theta_{ATTACK}$$

$$Y_4 = Y_3 - e_1R_1 \sin \theta_A + e_2R_2 \sin \theta_{ATTACK}$$

$$\rho_k = \frac{V_T}{V_K}$$

$$\left(\rho_{cL}\right)^2 = 1 + \rho_k^{\ 2} - 2\rho_k \cos\theta_{COMD}$$

$$T_T = \frac{2\pi R_1}{V_k} e_1 \left[\theta_{COMD} - \theta_T\right]_{MOD\ 1} + \frac{2\pi R_2}{V_2} e_2 \left[\theta_{ATTACK} - \theta_{COMD}\right]_{MOD\ 1}$$

$$d_c = e_1R_1 - e_2R_2$$

$$d_1 = Y_4 - T_TV_T$$

$$d_2 = -X_4 - \rho_k d_c$$

$$d_3 = d_c + \rho_k X_4$$

TABLE IX (CONTINUED)

MISS DISTANCE $d_m = d_1 \sin\theta + d_2 \cos\theta + d_3$

SOLUTION OK IF: $\left| d_m \right| < \text{MAX}\left[\frac{3}{4}, \frac{1}{128}\,\text{TTG}\right]$

TIME-TO-GO TILL INTERDICTION OR RENDEZVOUS

$$\text{TTG} = \frac{2\pi R_2}{V_2}\, e_2 \left[\theta_A - \theta_c\right]_{\text{MOD }1}$$ FOR RENDEZVOUS AFTER OFFSET

$$\text{TTG} = T_p + T_{js} + \Delta T_V$$ FOR ALL OTHER OPTIONS

$$T_p = \frac{R}{V_k}$$ FOR FIRST PHASES OF COMPUTATION

$T_p =$ TIME OF CURRENT MIN. SOLUTION, WHEN AVAILABLE

INTERDICTION OR RENDEZVOUS POINT LOCATION

$$X_c = X_T + (\text{TTG})(\dot{X}_T)$$

$$Y_c = Y_T + (\text{TTG})(\dot{Y}_T)$$

FUEL RESERVE AFTER INTERDICTION OR RENDEZVOUS

$$F_{RES} = F_{OB} - F_I$$

TABLE IX (CONTINUED)

FUEL IMPOSSIBLE TEST

$$\text{IF} \quad F_{RES} \leq 0$$

$$T_A = T_{FT} + T_{js}$$

$$F_i = F_{c12} + T_A \dot{F}_{V22} + \left(TTG - TA - T_{c12} \right) \dot{F}_{V10}$$

* EXTREMES OF MISS DISTANCE

$$d_4 = \rho_k e_1 R_1 - \rho_2 e_2 R_2$$

EXTREME ANGLE

$$\begin{cases} \theta E_1 = \arc\cos \dfrac{d_3 + \sqrt{d_3^{\,2} + 4d_4 \left(d_4 + d_2 \right)}}{2d_4} \\[2ex] \theta E_2 = \arc\cos \dfrac{d_3 - \sqrt{d_3^{\,2} + 4d_4 \left(d_4 + d_2 \right)}}{2d_4} \\[2ex] \theta E_3 = 1 - E_1 \\[1ex] \theta E_4 = 1 - E_2 \end{cases}$$

DISCONTINUITIES θ_{ATTACK}, T

THESE 6 ANGLES ARE ORDERED AND COMPARED TO PERMITTED INTERVALS

* NOTE:

THIS METHOD OF EVALUATING NEW SOLUTIONS WILL BE REPLACED BY EXPLICIT OR IMPROVED SEARCH TECHNIQUES IN SUBSEQUENT DOCUMENTATION AS COMPUTATIONALLY-SUPERIOR METHODS ARE DEVELOPED.

TABLE IX (CONTINUED)

PERMITTED INTERVALS OF MISS DISTANCE

IF $|d_c| > |X_4|$ $\qquad \theta_p = \arc\cos\left(\frac{X_4}{d_c}\right)$

OTHERWISE $\qquad \theta_p = \frac{1}{256}$ IF $\frac{X_4}{d_c}$ IS POSITIVE

$\qquad = \frac{127}{256}$ IF $\frac{X_4}{d_c}$ IS NEGATIVE

IF $|d_c| + 0.25 < |X_4|$ AND

$X_4 \leq 0$ INTERVAL $= 0 \leq \theta \leq \frac{1}{2}$

$X_4 > 0$ INTERVAL $= \frac{1}{2} \leq \theta \leq 1$

IF $|d_c| + 0.25 \geq |X_4|$ AND

$d_c < 0$ INTERVALS $= \theta_p \leq 0 \leq \frac{1}{2}$ AND $1 - \theta_p \leq \theta \leq 1$

$d_c > 0$ INTERVALS $= \theta \leq \theta \leq \theta$ AND $\frac{1}{2} \leq \theta \leq 1 - \theta_p$

DETERMINING SUBINTERVALS

ANGLES WHICH OCCUR IN PERMITTED INTERVALS FORM SUBINTERVAL BOUNDARIES

ANGLES WHICH FALL ON BOUNDARY OF INTERVALS ARE DISCARDED

TABLE IX (CONTINUED)

TESTING SUBINTERVALS

LIMITS OF INTERVAL = θ_1 AND θ_2

DETERMINE d_m FOR θ_1 AND θ_2 = d_{m1} AND d_{m2}

IF $\left(d_{m1}\right)\left(d_{m2}\right) < 0$ SOLUTION EXISTS IN SUBINTERVAL

DETERMINE d_m FOR $\theta_{mid} = \frac{1}{2}\left(\theta_1 + \theta_2\right)$

IF $\left(d_{m1}\right)\left(d_{m_{mid}}\right) < 0$ SOLUTION EXISTS IN LOWER SUBINTERVAL

IF $\left(d_{m2}\right)\left(d_{m_{mid}}\right) < 0$ SOLUTION EXISTS IN UPPER SUBINTERVAL

CONTINUE SPLITTING SUBINTERVAL CONTAINING SOLUTION UNTIL $d_m = 0$

OR SUBINTERVAL IS $\leqslant \frac{1}{256}$, THEN SAVE d_m AND TEXT NEXT INTERVAL

IF $d_m \neq 0$ WITHIN ANY SUBINTERVAL

TABLE IX (CONTINUED)

DETERMINE IF $|d_{m1}|$ OR $|d_{m2}| \leq \frac{1}{2}$. IF SO SAVE d_m AND TEST NEXT

TIME FOR SOLUTION

$$T_B = \frac{1}{V_k (\rho_{c1})^2} \left[(\rho_k d_c - X_4) \sin \theta_i + d_{1i} (\rho_k - \cos \theta_i) \right]$$

$$T_{Ti} = T_{T_X} + \left[\frac{2\pi e_1 R_1}{V_k} - \frac{2\pi e_2 R_2}{V_2} \right] \theta_j - \theta_X$$

i = 1 FOR SOLUTION AT LOWER END

2 FOR SOLUTION AT HIGHER END

3 FOR SOLUTION AT MIDPOINT

$$T_p' = T_B + T_T$$

NEW SOLUTION

IF $T_p' < T_p$ STORE T_p' AS MINIMUM

AFTER EVALUATING ALL SUBINTERVALS AND TURN COMBINATIONS, STORED T_p OR T_p' WHICH IS MINIMUM REPRESENTS MINIMUM TIME SOLUTION

IF NO SOLUTION EXISTS, THE ABOVE EQUATIONS SHALL BE RE-EVALUATED USING OTHER VALUES OF θ_b

TABLE IX (CONTINUED)

IF ONE LIMIT $\neq \theta_T$ NO SOLUTION EXISTS; TEST NEXT SUBINTERVAL

IF ONE LIMIT $= \theta_T$ AND OTHER $\neq \theta_A$ SOLUTION EXISTS AT END i IF $|d_{mi}| < k$

IF ONE LIMIT $= \theta_T$ AND OTHER $= \theta_A$ REVERSE DIRECTION OF e_2 AND SOLVE AGAIN

IF ONE LIMIT $\neq \theta_A$ NO SOLUTION EXISTS; TEST NEXT SUBINTERVAL

IF ONE LIMIT $= \theta_A$ AND OTHER $\neq \theta_T$ SOLUTION EXISTS AT END i IF $|d_{mi}| < k$

OTHERWISE NO SOLUTION EXISTS   TEST NEXT SUBINTERVAL

TURN COMBINATIONS

1. SIGN OF e_1 = SIGN OF d_m

   SIGN OF e_2 = SIGN of e_2 FOR PREVIOUS ACCEPTED SOLUTION

2. SIGN OF e_1 = SIGN OF d_m

   SIGN OF e_2 = - SIGN OF e_2

TABLE IX (CONCLUDED)

FACTORS

θ_b	=	60°	FOR INITIAL TURN
	=	30°	FOR ALL OTHER TURNS UNLESS NO SOLUTION IS FOUND
Z_2	=	Z_T	
D_j	=	10	FOR AIR-TO-GROUND ATTACK
	=	0	FOR CUTOFF
	=	1	FOR RENDEZVOUS
	=	4	FOR ALL OTHERS
ψ_T	=	0°	FOR ZERO VELOCITY TARGET
$\emptyset$	=	0°	FOR RENDEZVOUS
	=	110°	FOR CUTOFF
	=	ARBITRARY	FOR ARBITRARY HEADING
e_1, e_2	=	+1	FOR STARBOARD
	=	-1	FOR PORT
T_{js}	=	70	
k	=	3/4	
R_2	=	0	FOR CUTOFF
F	=	0	FOR CUTOFF

Testing for Acceptable Solutions

The Navigation function shall periodically recalculate the perpendicular distance from the target or destination to the trainer's projected flight path measured at the instant the trainer's path crosses the target or destination flight path. If the calculated miss distance exceeds a predetermined acceptable magnitude proportional to time till interdiction, the function shall recompute the guidance equation solution. If the error is acceptable, the function shall continue the current command heading and speed.

Testing for Impossible Solutions

The Navigation function shall determine after each new computation whether or not the mission is possible based upon the trainer's performance and fuel data in accordance with Table VIII, on page 41. If no possible solution exists, the function shall cause preparation of a warning display. Vectors on the present heading shall continue to be prepared for display.

AIR-TO-GROUND ATTACK

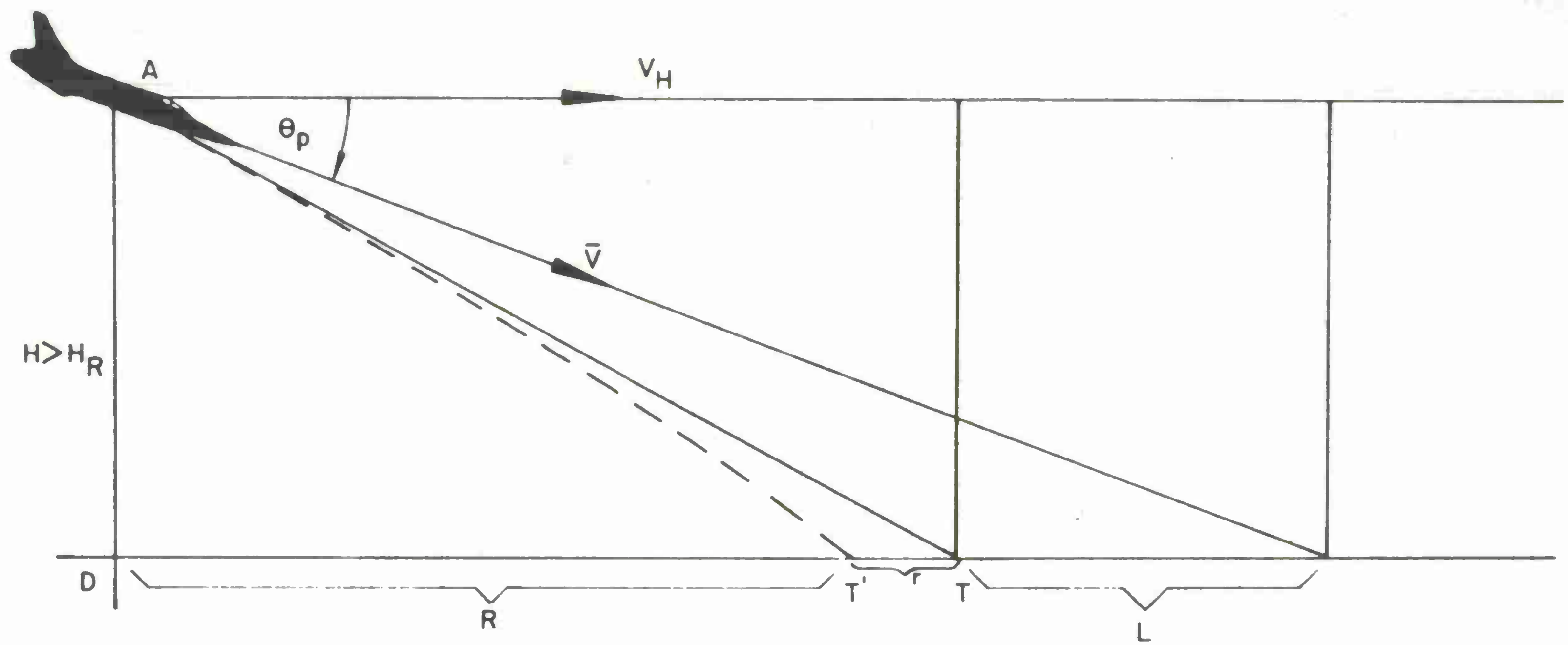
The Air-to-Ground Attack function shall perform all computations required for display of weapons delivery information during ground attacks. It shall compute the line along which a bomb will land; the point at which it will hit when released; the solution cue marker, which moves through the target at release time; trainer command parameters; limits, warning indicators, target markers, and Impossible Delivery indicators, as described below.

The Air-to-Ground Attack function shall provide the pilot with a choice of three weapons types, two delivery modes, and two release modes as detailed below.

The function shall perform its calculations a minimum of ten times per second as required to ensure display of timely trainer steering information.

Weapons Characteristics

The central tables shall permit storage of the relevant characteristics of three Air-to-Ground weapons. These characteristics are a function of both true air speed and altitude above target. These characteristics may be stored in either tabular form or as brief empirical equations from which the values can be obtained.



TRAINER AT A, DIVING AT ANGLE θ_p, RELEASES BOMB TO HIT TARGET AT T
BOMB FALLS TO TARGET AT T'

L = AIMING ALLOWANCE
R = HORIZONTAL RANGE TO TARGET FROM TRAINER AT RELEASE
θ_p = DIVE ANGLE BELOW THE HORIZONTAL, = 0 FOR LAYDOWN
$\bar{V}$ = TRUE AIRSPEED VECTOR
r = TRAIL
H = RELEASE ALTITUDE
H_R = MINIMUM ALTITUDE RESTRICTION
V_H = HORIZONTAL VELOCITY

Figure 21. Laydown and Dive Bombing

Characteristics used for computing the delivery of each weapons shall consist of Sight Depression Angle in units of bombing mils, Time of Flight in units of seconds, Ballistic Coefficient, and Toss Bombing Correction Factor. Values shall be provided for entry into the data base from standard Air Force Ballistic Tables.

Weapons Delivery Modes

Laydown and Dive Bombing Mode

The geometry of dive and laydown bombing is shown in Figure 21. Equations in Table X shall be used for both the laydown and dive bombing solutions.

In laydown bombing the trainer flies level and releases its bomb to fall through the air the remaining distance to the target. In dive bombing the trainer releases its bomb while diving towards a point on the ground a distance beyond its target, to avoid having the bomb fall short.

TABLE X

LAYDOWN AND DIVE BOMBING EQUATIONS

BOMB FALL LINE

LINE THROUGH HEADING OF TRAINER

$$m = \tan \theta_h$$

$$y = mX + \left[Y_a - mX_a \right]$$

SOLUTION CUE

MARKER TO MOVE THROUGH TARGET AT RELEASE TIME

HORIZONTAL VELOCITY OF TRAINER

$$V_H = V \cos \theta_p$$

TRAIL DUE TO BOMB DRAG

$$r = \frac{H \theta_r}{1000}$$

PRESENT RANGE TO TARGET FROM TRAINER

$$R_T = \left[(X_T - X_a)^2 + (Y_T - Y_a)^2 \right]^{1/2}$$

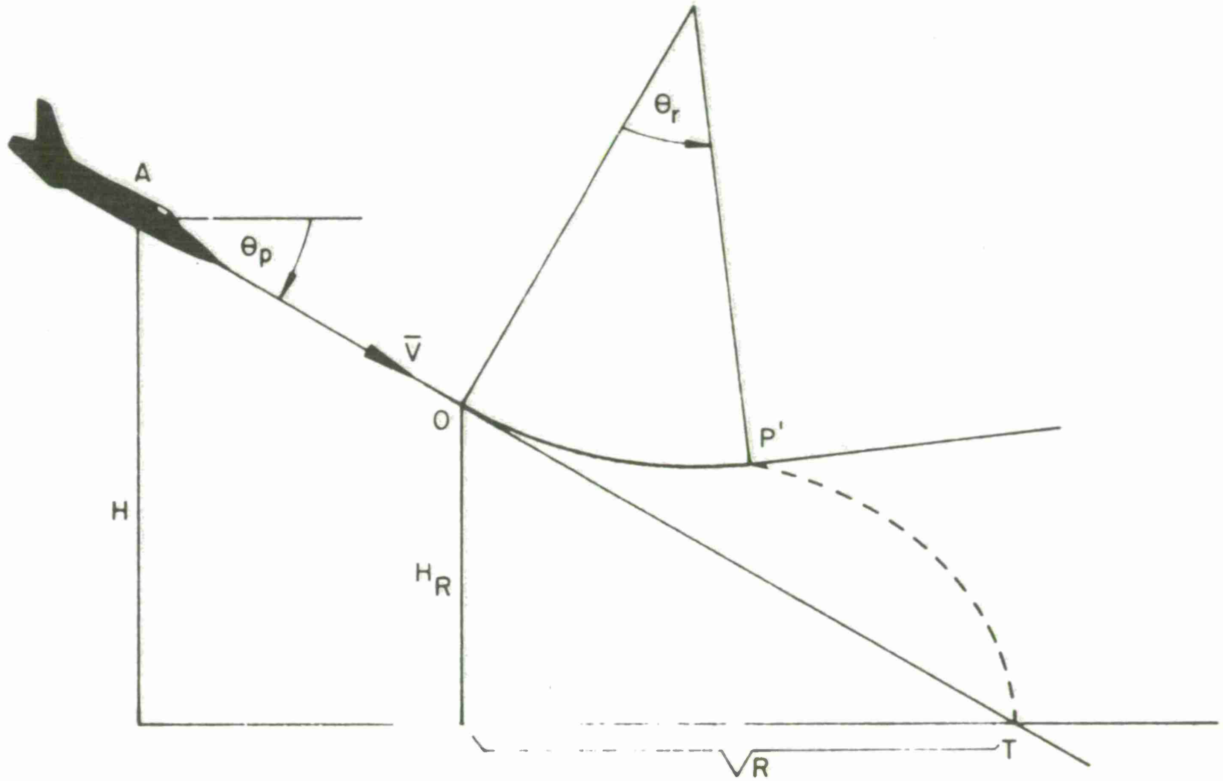
RANGE FROM TRAINER TO TARGET AT RELEASE

$$R = V_H t_f + r$$

IMPOSSIBLE DELIVERY

NO SOLUTION EXISTS FOR DIVE BOMBING IF

$$\theta_p > \arctan \frac{H_R}{R_T}$$



θ_p = DIVE ANGLE BELOW THE HORIZONTAL
θ_r = RELEASE ANGLE
H = ALTITUDE AT START OF RUN
H_R = ALTITUDE AT PULL-UP
OP' = PULL-UP ARC

O = PULL-UP POINT
$\bar{V}$ = TRUE AIRSPEED VECTOR
P' = RELEASE POINT
R = HORIZONTAL DISTANCE FROM PULL-UP POINT TO TARGET

TRAINER AT A DIVES TOWARD TARGET T. AT POINT O IT PULLS UP WITH CONSTANT SPEED. BOMB IS RELEASED AT P' AND STRIKES TARGET AT T.

Figure 22. Toss Bombing

Delivery geometry shall be monitored by the Air-to-Ground Attack function. If dive angle is so steep that the bomb will fall short, a warning display shall be generated to indicate an Impossible Delivery.

Toss Bombing Mode

In the Toss Bombing Mode the trainer dives directly at its target. To keep its bomb from falling short, it pulls up in a constant speed arc. After a measured time of pull-up, it releases its bomb which is lofted forward to the target. Since the pull-up time calculation includes the effect of bomb characteristics, the bomb will fall directly on the target. Figure 22 shows the geometry of this delivery.

The Air-to-Ground Attack function shall perform all computations necessary to provide both pull-up and release cues, as shown in Table XI.

TABLE XI

TOSS BOMBING EQUATIONS

AVERAGE NORMAL ACCELERATION OF TRAINER ALONG THE PULLUP ARC $\bar{\mu} = \sum_{i=1}^{n} \frac{a_{z_a}}{n}$

CLOSING TIME-TIME TO DIVE INTO THE TARGET $t_c = \frac{H_R}{\sin \theta_p} \; \frac{C + kV}{CV}$

DISTANCE FROM TARGET TO PULLUP CUE $d_p = (H - H_R) \cot \theta_p$

RELEASE TIME

$$t_r = \frac{2 t_c \cos \theta_p}{\left(\bar{\mu} + \cos \theta_p + \sqrt{\bar{\mu}(\bar{\mu} + \cos \theta_p)}\right)\left(\sqrt{1 + \frac{\bar{\mu}}{\bar{\mu} + \cos \theta_p} \cdot \frac{2 g t_c \sin \theta_p}{V}} - 1\right)}$$

SOLUTION CUE VELOCITY

$$\text{Velocity} = \frac{H_R \cot \theta_p}{t_r}$$

IMPOSSIBLE DELIVERY

No solution if $\theta_p > \arctan \frac{H_R (C + kV)}{R_T C}$

Release Modes

The Air-to-Ground Attack function shall simulate automatic release of the weapon if switch insertions have specified that mode. At the time when the solution cue reaches the target, a display format indicating weapons release shall be generated for display. If switch insertions have specified manual release, the display format shall be generated when the pilot makes the release insertion. In both modes a bomb impact display shall be generated when the bomb fall time has elapsed. This display shall show the bomb impact point by a unique symbol.

Displays

The Air-to-Ground Attack function shall prepare data for use by the display function in preparing the Attack Display. The data shall include a target marker symbol to be displayed at the location of the target; a bomb fall line across the display through the heading of the trainer; a solution cue which will pass through the target marker at the time of release; a "pull-up" indication when the minimum altitude restriction is being violated; a pull-up anticipation cue to indicate the instant of pull-up during toss bombing, and an Impossible Delivery indicator when dive or toss bombing angle is too steep.

Inputs

The computations by this function require that the information shown in Table XII shall be available in the central tables.

TABLE XII

DATA REQUIRED FOR AIR-TO-GROUND ATTACK

θ_p	=	TRAINER PATH ELEVATION ANGLE	V_x, V_y	=	TRAINER TRUE AIRSPEED COMPONENTS
a_{Z_a}	=	TRAINER NORMAL ACCELERATION	X_A, Y_A, H	=	TRAINER LOCATION
θ_r	=	BOMB SIGHT DEPRESSION CHARACTERISTIC	X_T, Y_T, H_T	=	TARGET LOCATION
t_f	=	BOMB FALL TIME CHARACTERISTIC	V_R	=	SPEED RECOMMENDATION
C	=	BOMB BALLISTIC COEFFICIENT	θ_{h_R}	=	ATTACK HEADING RECOMMENDATION
K	=	TOSS BOMBING CORRECTION FACTOR	H_R	=	MINIMUM PULLUP ALTITUDE REQUIREMENT
g	=	GRAVITATIONAL CONSTANT			

SECTION III

PROGRAM ORGANIZATION AND PHASING

ORGANIZATION

Five major programs shall be prepared. Each is outlined in a section below. Only the Operational Program organization is discussed in detail below.

Startup Program

The Startup Program shall initialize all items and counters for the system; accept simulation inputs; prepare the Startup Display and accept joystick inputs relative to that display.

Equipment Checkout Program

The Equipment Checkout Program shall process trainer inputs; prepare the results in the Navigation Display format; address the displays to each trainer; accept function switch inputs in response to the displays; interpret the results; and printout test results on the line printer.

Simulation Preparation Program

The Simulation Preparation Program shall generate and verify time-tagged simulated data in a form compatible with the requirements of the Simulation Input Processing function of the Operational Program and output that data onto magnetic tape or punched-paper tape, as specified.

Data Reduction Program

The Data Reduction Program shall accept data reduction control inputs and magnetic tape containing recorded data. It shall extract the items specified by the data reduction control inputs and perform all required mathematical, geographical and statistical calculations. It shall output the requested information on the line printer in decoded readable formats or output the reduced data onto magnetic tape for later printout.

TABLE XIII

PROGRAM SIZE & TIMING

FUNCTION	FREQ (TIME/SEC)	SIZE (REG_{10})	TIME (MS/SEC)	COMMENT
NAVIGATION	1	4000	120	
AIR-TO-GROUND ATTACK	10	1250	400	
DATA EXCHANGE	2/10	50	12	
FLIGHT DATA INPUT	10	70	10	
FILTERING	100	50	10	
SWITCH INPUTS	1*	70	1	*OPERATES ON INTERRUPT BASIS
DISPLAY	10	3400	390	
RECORDING	100*	20	24*	*DEPENDS UPON DATA TO BE RECORDED
SIMULATION INPUTS	10	20	15	
CONTROL	100	350	25	
TOTAL	---	~10,000	~1,000	

Operational

The Operational Program shall perform the functions detailed in Section II. Each subroutine shall be operated according to preset values in a sequence parameter table. All requests by subroutines shall be considered by the Control function described below. All subroutines shall utilize common data from central tables as described below. Estimated program size and timing are shown in Table XIII.

Control Function

Program timing shall be controlled by the periodic overflow of a clock register. In response to this overflow interrupt, the Control function shall increment and examine each sequence parameter. Those parameters whose values indicate that their subroutines should run shall cause the Control function to request an interrupt.

The Control function shall save all registers required for subroutines in progress to permit subroutines interrupted at any point to resume after hardware service subroutines have been completed.

The Control function also shall respond to requests for servicing by all hardware devices including joystick or switch ENABLE interrupts, analog-to-digital conversion completions, and standard input-output peripherals, in accordance with their assigned priority levels.

Central Tables Organization

All inter-subroutine communications shall be by means of central tables. All messages, switch or flight data inputs shall be adequately buffered to prevent new inputs from disturbing calculations in progress. Subroutines shall extract the data required for their calculations from the central tables. Upon completion they shall insert altered calculated values into the central tables with adequate interlocking to permit updating as soon as a table is not in use but prevent disruption of other calculations which may be in progress. A unique error lamp indication shall be provided when any buffer or table is approaching its capacity limits.

PHASING

Three program packages shall be delivered. The first shall include the Equipment Checkout Program to verify trainer performance; an Initial Operational Program; and a Data Reduction Program adequate for program checkout. The second shall include the Startup Program to initialize all values; a Thin Operational Program; a Simulation Preparation Program; and additional Data Reduction Programs to support system testing. The final package shall include the full capability described in Section II with a supporting Data Reduction Program. The operational functions to be provided in each package are described in the sections below.

Initial Capability

This capability will permit the two trainers to participate on a limited basis in the PLRACTA network. It shall not provide switch action inputs, Navigation calculations or Air-to-Ground Attack calculations. It shall include a Control function to support the initial package, with a design adaptable to future phases. It shall accept all trainer flight inputs. It shall accept all PLRACTA message inputs. It shall output Position-Status messages to the network. It shall provide a predetermined set of displays in both trainers. In support of program checkout, it shall accept simulated data inputs and shall record data for analysis.

Thin Capability

This package shall augment the previous package functions to permit full operation as PLRACTA-equipped tactical aircraft. It shall accept all switch action inputs. It shall prepare all displays. It shall vector trainers to specified targets using only the cutoff tactic. It shall compute and display only laydown and dive bombing solutions.

Full Capability

This package shall complete the simulated-avionics capability by augmenting the previous package. It shall provide all navigation tactics; all bombing modes; all displays; and the preparation, display and output of Airborne Forward Air Controller messages.

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* The MITRE Corporation Bedford, Massachusetts	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

AIRCRAFT MOCK-UP COMPUTER PROGRAM SPECIFICATIONS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

Richard E. Zapolin

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
MARCH 1971	71	0

8a. CONTRACT OR GRANT NO. F19(628)-71-C-0002 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) ESD-TR-71-80 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* MTR-1995

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Electronic Systems Division, Air Force Systems Command L. G. Hanscom Field, Bedford, Massachusetts

13. ABSTRACT

A computer program operating in the DEC PDP-15 will simulate programs in avionics computers aboard the two simulated jet aircraft. General performance and design specifications for this computer program, program organization and a phasing plan are presented. Further detail will be published in the PLRACTA System Test Configuration documentation.

DD FORM 1 NOV 65 1473

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
AIRBORNE COMPUTERS - TACTICAL TESTBED						
COMPUTER SYSTEMS HARDWARE						
DATA PROCESSING						
DATA PROCESSING EQUIPMENT						
MINI-COMPUTERS						
NAVIGATIONAL COMPUTERS						
POSITION LOCATION, REPORTING AND CONTROL OF TACTICAL AIRCRAFT (PLRACTA)						
REAL-TIME DATA PROCESSING						
TELECOMMUNICATION						
TELEMETRY						